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Economic Impact Analysis of Proposed Testing Regulations for Chloromethane and Chlorobenzenes

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16. ABSTRACT

This report presents the methodology that will be used for analyzing the economic impact of this and future test rules. The methodology follows a two-stage approach. All chemicals are subjected to a Level I Analysis. This analysis consists of evaluating four market characteristics: demand sensitivity, costs, industry structure, and market expectations. The results of the Level I analysis (along with a consideration of the costs of the required tests) indicate the potential for significant adverse economic impacts. Where the indication is negative, no further economic analysis is required. However, for those chemical substances or groups where the Level I analysis indicates a potential for significant economic impact, a more detailed and comprehensive analysis is conducted. This Level II analysis attempts to predict more accurately whether or not this potential will be realized, and, if so, its magnitude.

The Level I analysis for chloromethane indicates that the proposed health effects test rule will not impose any significant economic impact on manufacturers of chloromethane. For the chlorobenzenes group, the results of the Level I analysis indicated that a potential for economic impacts exists; however, the Level II analysis concludes that the economic impacts are expected to be minor.

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ECONOMIC IMPACT ANALYSIS OF PROPOSED TESTING REGULATIONS FOR CHLOROMETHANE AND CHLOROBENZENES

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B

PREFACE

The attached document is a contractor's study done with the supervision and review of the Office of Pesticides and Toxic Substances of the U.S. Environmental Protection Agency. The purpose of the study is to analyze the potential economic impact on manufacturers complying with proposed testing rules. These proposed rules were prepared by the EPA Office of Pesticides and Toxic Substances to implement Section 4 of the Toxic Substances Control Act.

This report was submitted in fulfillment of Task Order Number 1 of Contract Number 68-01-5864, by MATHTECH, Inc. Work was completed as of May 1980.

This report is being released and circulated at approximately the same time as publication in the Federal Register of a proposed health effects test rule under Section 4 of TSCA. The study is not an official EPA publication. It will be considered along with any comments received by EPA before or during the proposed rulemaking proceedings in establishing final regulations. Prior to final promulgation of these test rules, the accompanying study shall have standing in any EPA proceeding or court proceeding only to the extent that it represents the views of the contractor who performed the study. It cannot be cited, referenced, or represented in any respect in any such proceedings as a statement of EPA's views regarding the subject industry or the economic impact of the regulation.

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CHAPTER I

EXECUTIVE SUMMARY

I.A. Introduction

The Toxic Substance Control Act (TSCA, 15 USC 2601) was signed into law in October 1976. It was the culmination of several years of debate and evaluation regarding the role of the Federal government in protecting the populace from the effects of toxic substances in the environment. One of the major focuses of TSCA is to determine the toxic effects of existing and potential substances.

In order to implement this objective of TSCA, sets of testing requirements are being developed on a case by case basis. Section 4(b)(1) of TSCA instructs the EPA Administrator to consider the relative costs of various test protocols and methodologies which may be required. In general, emphasis is placed on considering the economic impacts of actions taken under the Act in addition to environmental and social impacts.

The purpose of this study is to determine when significant economic impacts may occur as a result of particular testing regulations and to estimate the magnitude of these impacts. Although benefits to society, such as a reduction of disease incidence, may result from the testing of chemical substances, this study deals only with the economic costs associated with imposing testing regulations.

I.B. Objectives and Methodology

In order to determine the economic impact of testing requirements, a two-level impact analysis scheme has been devised. The overall objectives of these analyses are (1) to determine whether there is any significant potential for adverse economic impact resulting from testing regulations; and (2) where the possibility of an adverse impact exists, to estimate the magnitude of the economic impact. Level I economic impact analysis is concerned with the first objective, whereas Level II deals with in-depth analysis of impacts.

I.B.1. Level I Economic Analysis

Level I Analysis involves determining whether the potential for adverse impact exists. As such, it investigates those market characteristics which indicate the likelihood of economic impacts due to the regulation. The market characteristics investigated in Level I analysis include: (1) demand sensitivity, (2) cost characteristics, (3) industry structure, and (4) market expectations.

The information concerning these factors must be readily developed, so that all substances recommended for EPA consideration by the Interagency Testing Committee, or selected by EPA for possible testing, can be subjected to Level I Analysis. In light of this, the tests chosen and the variables examined to determine the potential for impact must be conservative in nature. That is, we wish to minimize the probability of falsely rejecting a chemical substance for Level II analysis; i.e., a Level II analysis should be indicated if there is any possibility of adverse economic impact.

I.B.2. Level II Economic Impact Analysis

For those chemical substances where Level I analysis indicates a significant potential for adverse economic impacts, a comprehensive economic impact analysis is conducted. At this level an in-depth investigation concerning the market characteristics is undertaken and estimates of the important variables are made. The direct cost of the test protocol is integrated with these estimates in order to determine the magnitude of the economic impacts.

I.C. Conclusions

I.C.1. Acrylamide

No testing requirement for acrylamide is being proposed. Therefore, an economic impact analysis was not performed on this chemical.

I.C.2. Chloromethane--Level I Analysis

As described above and discussed in Chapter II, a set of four market attributes are investigated in order to determine the potential impact of testing requirements. The results of these investigations indicate that the chloromethane industry should be relatively well-insulated from significant adverse economic impacts.

This conclusion is based upon the following considerations: First, demand for chloromethane appears to be insensitive to changes in price. That is, an increase in price is expected to result in a proportionately smaller decrease in the quantity demanded. The primary use of chloromethane is in the production of silicones, and the demand for silicones is particularly insensitive to price. In addition, the market for silicone products is clearly expanding, indicating that the demand for chloromethane will be increasing.

The cost structures for each firm in the industry appear to be relatively similar. This is because the production process is simple and almost universally employed. This would indicate a competitive market situation and no individual firm can be singled out as particularly susceptible to adverse impact due to testing costs.

In light of the results, a Level II analysis does not appear to be required.

I.C.3. Chlorobenzenes--Level I and Level II Analysis

From a Level I investigation of the four market characteristics discussed in Chapter II, it was determined that a potential for economic impact exists for the chlorobenzenes industry.

The highest volume chlorobenzene is monochlorobenzene, which is used primarily as an organic intermediate for the manufacture of numerous organic compounds. The market for monochlorobenzene is characterized by many potential substitutes which suggests that the demand for monochlorobenzene could be price sensitive. The commercial dichlorobenzenes (para- and ortho-) appear to face similar market conditions. Although the higher chlorobenzenes appear to face less competition from substitutes, their production levels are significantly lower. In addition to these market characteristics, the expectations for the chlorobenzene market appear to be quite low. This is due to their weak market performance over the past few years and pessimism regarding the outlook for end-uses of chlorobenzene.

On the cost side, due to the fact that the higher chlorobenzenes are produced sequentially, the cumulative effect of testing chlorobenzenes could be significant. The cost structures for firms in the industry appear to be similar and there are no unique factor inputs. Thus, in addition, the industry can be characterized as competitive.

On the basis of competitiveness, potential price sensitivity, and production complementarity, the chlorobenzenes can be considered a potentially sensitive product group and, thus, a candidate for Level II economic impact analysis.

The major findings of the Level II analysis do not support the conclusion of a significant economic impact from the imposition of testing regulations. Although the Level I analysis indicated potential price sensitivity, when the demands for the three lower chlorobenzenes were estimated all three demands were characterized as price inelastic. In addition to this, the testing costs, on an annualized basis, will not be large either in absolute or a relative sense, even when the effects of sequential "cascading" are considered.

The industry appears to have reorganized along more viable lines, as several financially marginal producers have abandoned the chlorobenzenes market in recent years. Although the domestic market outlook is static, growth in the export markets for chlorobenzenes may tend to mitigate these level expectations.

These factors lead to a conclusion that the economic impact of a chlorobenzenes testing rule will be minimal, at worst. This conclusion is valid for any of the three testing options considered, however, the proposed approach clearly produces the least impact.

I.D. Limits to Analysis

Analysis, such as described here, is invariably an uncertain instrument. For this reason, an approach based on the "worst case" has been developed. The objective is to never overlook a situation where substantial adverse economic impact may arise as a result of regulatory action.

The overall approach used here to analyse economic effects is that of partial equilibrium analysis. This approach considers all factors not directly accounted for in the analysis to be held constant.

Also, note that processors (according to common industry usage of the term) are not included in the impact analysis. To the extent that processors share the burden of test costs the costs to producers will be lower; thus, in the analysis, the impact on producers is probably overstated.

CHAPTER II

ECONOMIC IMPACT METHODOLOGY

II.A. Introduction

In keeping with the overall objectives of the Toxic Substances Control Act, EPA intends to analyze the economic impact of proposed Section 4 test rules. The objectives of these analyses are (1) to determine if there exists a potential for significant adverse economic impact as a result of imposition of a test rule, either at the level of the firm, the industry, or the economy as a whole; (2) to determine if that impact potential will actually be realized through imposition of a specific test rule; and (3) to estimate the magnitude of the potential economic impact.

The analytical methodology adopted to satisfy these objectives reflects the hierarchial nature of the objectives. Initially all chemicals and chemical groups subjected to testing requirements are examined to determine the potential for adverse economic impact. Those found to possess a significant potential are further examined to determine the extent to which specific rules will cause this potential to be realized. Ultimately those deemed sensitive to testing requirements (i.e., high testing costs and vulnerable market characteristics) are examined in detail in order to quantify the full range of economic impacts that may be associated with the rule.

The methodology for determining impact potential for all chemicals is termed, "Level I Analysis." The in-depth analysis of economic impacts for chemicals targeted during the initial procedure is termed, "Level II Analysis." The following sections outline these methodologies in more detail.

II.B. Level I Economic Impact Analysis

As described above, Level I analysis acts as a filter to allow those chemical substances potentially adversely impacted to be differentiated from others. This is determined by the incidence of testing costs and the existence of certain market characteristics. The market characteristics of interest are those readily available parameters that can signal the presence of potential for economic impact as a result of regulatory action.

EPA's approach to screening chemicals for economic effects due to testing requirements is conservative in nature. That is, EPA has decided that for this purpose, it is more desirable to err on the side of signalling potentially significant impact when there is none, than it is to conclude that further economic analysis of the impact on a chemical is unnecessary, when in fact there may be economic effects.

The market characteristics selected for Level I consideration are also those important for Level II analysis and fall, generally, into four major categories: demand sensitivity, market expectations, cost characteristics, and industry stucture. Level II analysis treats these categories in a more rigorous and quantitative manner.

II.B.1. Demand Sensitivity

The imposition of testing rules under the Toxic Substances Control Act manifests itself, in an economic sense, principally through the price mechanism. This is the basic premise upon which both Level I and Level II analyses are based.

The cost of testing chemical substances can be considered an additional fixed cost; the total cost of testing does not vary with the total level of production of the chemical. (However, depending on the reinbursement scheme decided upon, the cost to an individual firm may be affected by that firm's level of production, processing or sales.) As such, the cost of testing raises the firm's total costs and average cost (average cost is the total cost divided by the quantity produced). For those firms where the average cost exceeds the price received, the rational decision is to allocate resources to other more productive uses rather than to continue producing the chemical in question. Thus, the industry becomes willing to supply less and the price of the product rises.

Adverse economic impacts generally arise through reductions in the quantity demanded of the regulated chemical due to the higher price. The magnitude of this demand reduction (and thus, of impact) is critically dependent upon the sensitivity of demand to price; that is, how much demand declines when the price rises.

Level I methodology requires a detailed description of the uses for the subject chemical substance. Each use is examined to determine principal and potential substitute substances and their prices. Given this information, it is possible to judge the probable sensitivities of the various markets for the chemical, i.e., many good substitutes lead to an initial presumption of sensitivity to impact, and conversely, lack of good substitutes leads to a presumption of insensitivity. This is true even for "captive" markets where vertically integrated firms produce chemicals for their own use alone. In the long run, no firm can be expected to continue consuming its own products if it can buy comparable materials externally at a lower overall cost.

While sensitivity information is assigned considerable importance in deciding whether or not to subject a substance to Level II analysis, demand cannot often be unambiguously labeled either "sensitive" or "insensitive." Thus, information on substitutability must be integrated with information from other categories in order for an informed judgement to be made.

II.B.2. Market Expectations

Level I analysis requires an investigation of chemical end-use markets to determine their broad, long term outlook.

In the absence of specific information, current and recent historical trends are assessed on the presumption that expectations are conditioned, in large part, by near term performance. High market expectations, of course, will tend to lessen the potential for economic impact from testing regulations, while low expectations will increase it.

Firms will treat the costs of EPA's testing rules in a manner analogous to conventional capital investment. This means that firms will consider not only current profitability but also future expectations for the chemical to be regulated. Obviously, many factors enter into a firm's assessment of the future, and many exist on a totally ad hoc basis with little applicability in a categorical sense among different firms and products. Others are capable of at least limited assessment. For instance, regulatory requirements addressing air and water pollution problems may have powerful market effects quite unrelated to TSCA.

II.B.3. Cost Characteristics

The behavior of production costs at the level of the firm and of the plant is an important indicator of the probability of impact. Generally speaking, if a plant is operating at a point where product price just covers average cost, imposition of testing costs will force it to abandon the market (assuming other factors do not change). On the other hand, if the industry as a whole is operating at a point where price exceeds average cost, there is a good probability that testing costs can be absorbed (i.e., in the form of decreased profit) with no effect on price or production at all.

There are two particularly important points to be examined in this area at Level I. The first is the existence of unique production factors. These could take the form of a proprietary, low cost production process, a unique source of raw material, or a particularly advantageous geographical location (when transportation costs are a factor). The presence of any of these factors signals that firms are in a position to at least partially absorb testing costs.

Another major factor is the presence of complementarity in production. Often several chemicals are produced jointly within the same process. While the proportions of each might be subject to variation within physical limits, it is impossible to produce one without producing significant quantities of the others. Thus, an investment decision involving one of such a group of chemicals must be examined in light of the entire group. In such cases, the presence of a commercially valuable by-product can mitigate the effects of testing costs, since the incremental average cost would be distributed over a larger quantity of outputs. This situation will tend to insulate the target chemical from the imposition of testing costs. On the other hand, if testing costs make the entire group unattractive economically, the resulting economic impact can have multiple effects.

II.B.4. Industry Structure

Industry structure refers in an economic sense to the number and size distribution of producers. It is usually cited as an indicator of the presence of competitive or noncompetitive forces in a particular market. The existence of a single producer, for instance, is usually a strong indication of monopolistic market behavior, while many small producers probably indicate competition.

Markets that to one extent or another are noncompetitive are much more likely to absorb the cost of testing rules without adverse impact, than are competitive markets. Again, this result follows from the fact that noncompetitive behavior results in price being set in excess of average cost.

It should be noted that examination of industry structure does not encompass the overall size of firms. This is because testing costs represent an investment in the continuation of activity in certain markets and, as such, will be evaluated in the same manner as any other investment opportunity faced by a firm (i.e., will the return in the particular investment exceed the firm's cost of capital?). Each investment in testing costs will have to stand on its own, regardless of the size or structure of the firm.

II.B.5. Summary

Level I analysis is a means of selecting for further economic analysis those chemicals or groups of chemicals which are most likely to be adversely impacted by EPA testing rules. In general, those selected for in-depth (Level II) analysis will possess some combination of the following market characteristics:

- A number of good technical and economic substitutes in its most important end uses;
- An "impact prone" industry structure, characterized by intense price competition;
- Regional markets uninsulated by transportation costs;
- Absence of special production situations that would allow cost absorption;
- Nonoptimistic expectations for future market performance.

The process for ultimately weighing and balancing these factors at Level I is by necessity somewhat judgemental and qualitative; however, a key objective is to not mistakenly reject a substance for Level II consideration. Therefore, errors will be on the side of additional Level II analysis (i.e., for chemicals not impacted).

II.C. Level II Economic Impact Analysis

For each chemical substance for which it is determined through Level I analysis that a potential for adverse economic effect exists, an intensive economic impact analysis is conducted. Economic impact is considered within the conventional economic concept of opportunity cost, which is the value of foregone opportunities. The following section outlines the general approach followed in such an analysis and discusses the important factors in estimating the economic impacts. The steps involved in conducting Level II analysis build upon the foundation formed by the Level I analysis. Whereas, the Level I objective is to identify cases where a potential for economic impact exists, the Level II analysis attempts to quantify the factors considered to be of greatest importance. In order to estimate the economic impact of testing requirements, five areas of investigation are involved:

- Direct cost of the tests;
- Demand characteristics and substitution possibilities;
- Production cost behavior;
- Industry structure and competition; and
- Future market expectations.

Each of these will be discussed in turn.

II.C.1. Direct Costs

The initial step in determining the economic effects of test requirements is to determine the costs of the tests that may be required. The direct costs of testing are the costs of all tests required in the test rule. Direct costs are principally those associated with the testing laboratory. However, compliance with the test rules will also involve costs of an administrative nature. Since costs may vary substantially depending on the laboratory doing the testing and the specified parameters (level and number of doses, duration, labor productivity, and wage rates) a range of costs will generally be calculated. This range of costs is expected to encompass the minimum and maximum.

For economic impact evaluation, the total direct testing costs are computed on an annualized basis. Annualized costs depend on expectations about the future markets for the chemical. Therefore, the proper procedure is to discount the costs of testing over the expected life of the product. In most cases, a capitalization period of 20 years, and a pre-tax cost of capital of 20 percent, will be used. The capitalization period will be revised as necessary in light of the expectations concerning future markets.

II.C.2. Demand and Substitution

After the direct costs of the testing program have been determined, it is necessary to investigate the manner in which these costs interact with demand and other market factors to determine changes in price and output. The impact on price is of predominate importance, since price changes are the driving variables behind almost all subsequent impacts.

The effect of testing costs on the price of the substance is the result of the interaction of cost and demand factors. On the supply side, the total cost of a test rule can be considered an increase in the fixed cost of producing the chemical. That is, the cost depends on the number of tests required, not on the quantity of the chemical produced.

Thus, the marginal cost of producing the chemical is unaffected (marginal cost is additional cost of producing an additional unit of output) and the supply curve shifts principally in response to the decisions of individual firms to dispense with unprofitable facilities or to shift resources to more productive activities.

The degree to which the price of the chemical product will increase depends also on the demand for the product. The price elasticity of demand is used to measure this sensitivity. It is defined as the proportionate change in quantity demanded as a result of a small proportionate change in price ($\varepsilon_D = \%\Delta Q/\%\Delta P$). The elasticity of demand reflects such factors as the end-uses for the substance (and the demand for the final products), the substitutes for it (and their supply costs), and any complementary goods associated with it. Generally, through the use of econometric methods, the relevant variables (e.g., "own" price elasticity, cross-price elasticities, etc.) are estimated in order to determine the impact of the testing program on the production of the chemical substance and the effect on products which are substitutes for it.

Estimates of demand elasticity, when combined with information on direct testing costs, provide the essential basis for impact estimation. To fully understand the process, however, supply side variables must also be estimated.

II.C.3. Production Costs and Industry Structure

This component of the analysis links the outputs of the previous section to subsequent impacts on production, employment, and profitability, etc. It focuses primarily on the capital and operating costs associated with the chemical production process. Behavior of such costs is of interest initially in order to assess the ability of producers to absorb testing costs, and thus, on their ability to continue production.

In this respect, production costs are investigated from several standpoints. First of all, the peculiarities of the production processes involved are of central interest. The presence of joint products and complementarities may have considerable bearing on the economics of production for the substance being regulated. For joint products the costs of production must be considered together, in comparison to the revenues from all of the products. Thus, if testing costs are imposed on one product, the impact on total costs may be minor. On the other hand, if testing costs are imposed on several, or all, products, the cumulative impact on costs may be significant. In addition, fixed factors of production, such as patents and inputs from existing, upstream processes, can greatly affect cost functions. Such factors are extremely important in determining the ability of firms to absorb testing costs without adjusting price or quantity. They are evaluated through detailed engineering analysis.

Also important are questions of industry structure. These also reflect on the relationship between price and average cost, and help specify firm and industry behavior. The number of firms in the national market, as well as their plant size and size distribution, are examined. Transportation costs and market regionalization are investigated in order to determine if geographical location is a factor insulating firms from the effect of testing costs.

II.C.4. Expectations

Expectations play a very significant role in the firms' investment decision concerning testing costs. The costs of testing are a form of investment which may provide no increase in revenue and, thus, may decrease the overall rate of return on the company's investments. In estimating the effect of the testing costs on the investment decision, expectations about the demand for the product, future costs of capital, and the future costs of production inputs are crucial. If for example, demand is expected to increase significantly for a product due to the introduction of a new end use, the firm may be willing to "invest" in the testing rather than shut down the operation, which may have been the decision in the absence of the new market.

Unfortunately, expectations are a most difficult factor to quantify. Expectations formation models have been derived for various uses and these can be applied whenever feasible.

However, direct expectational information from the industry sources is perhaps more relevant. This is collected on an ad hoc basis and integrated to provide a picture of future trends.

II.C.5. Impact Assessment

The final step in the economic impact analysis brings together the results of each step of the investigation. At this point, the econometric estimates of demand elasticities are combined with the estimates of direct costs in order to determine price adjustments. These results are integrated with the results of the investment and industry analyses in order to predict the effects on production and employment, profitibility changes, and effects on other markets, etc. For purposes of this analysis, it is assumed that each producing firm pays a share of the test costs for those chemicals it produces, based on its proportion of production (processing firms are not considered at this point, since a definition of such will be clarified through comment on the proposed test rule)

$$(1) \quad C_{ij} = \alpha_{ij} T_i$$

where

C_{ij} = Test cost for the i^{th} chlorobenzene paid by the j^{th} firm

$\alpha_{ij} = P_{ij}/TP_i$

T_i = Total cost for testing the i^{th} chlorobenzene

P_{ij} = Production of the i^{th} chlorobenzene by the j^{th} firm

TP_i = Total production of the i^{th} chlorobenzene

The total cost imposed by testing a chemical substance is the sum of the costs to those firms producing it:

$$(2) \quad C_i = \sum_j C_{ij}$$

where

C_i = Total cost imposed by testing the i^{th} chemical.

It follows that the total costs of testing a group of chemicals (such as the chlorobenzenes) is the sum of the individual costs:

$$(3) \quad TC = \sum_i C_i$$

where

TC = Total direct costs of testing chlorobenzenes.

It should be noted further that this analysis treats testing costs as though they are all incurred in a single year. In reality, they will probably be incurred over a two-to-three-year period. To the extent that costs fall in other years, rather than immediately, the impact will be less, thus the "single year" assumption reflects the philosophy of conservatism (i.e., the "worst case" approach).

In addition to the direct effects, the impact on the users of the product (i.e., its consumers) due to the increase in price can be estimated. This utilizes the price elasticity of demand and the predicted price change to estimate the effects on consumers of the product. The measure of this effect is the change in consumers' surplus, which is the amount consumers would be willing to pay, to purchase given amounts, in excess of the amount actually paid. This can be considered the change in the net benefits consumers derive from the product. Of course, the consumers of the product will in most cases be producers themselves, and the change in consumers' surplus measures the impact on these subsequent producers.

In this manner, the results of all parts of the investigation are integrated and summarized. Thus, the quantified impacts are combined with the qualitative factors to produce a unified estimate of the probable economic impact of testing requirements.

II.C.6. Additional Considerations

Analysis such as described above, no matter how well executed, is invariably an uncertain instrument. Such uncertainty necessitates the use of the most conservative data and procedures in order that each estimate account for the "worst case." This is an overall policy applying to all components of the analysis at all times. The objective is never to overlook a situation where substantial adverse economic impact arises from regulatory actions.

The overall approach used here to analyze economic effects is that of partial equilibrium analysis. The approach considers all factors not directly considered in the analysis to be held constant. In most cases, this assumption is valid; the incremental costs of testing are small relative to total costs and no impacts outside the directly affected industry are expected. Thus, for example, the direct costs of testing are calculated by summing the costs of individual tests. However, depending on the tests required and their temporal sequence, a demand may be placed on testing laboratories and other specialized resources which, when combined with the supply or availability of factors may significantly affect the costs of testing. The result of this is that the cumulative impact of testing requirements may, in fact, be greater than the sum of the individual economic impact analyses.

It should also be noted that EPA's policy on testing cost reimbursement is a major uncertainty and is not thus far incorporated into the methodology in any rigorous way. The manner, distribution, and timing of reimbursement cash flows could conceivably affect the estimation of economic impact very broadly.

II.C.7. Summary

In summary, an economic impact analysis of EPA's test rules involves in-depth investigation of several factors related to the chemical production process. These factors are, for the most part, identified in the Level I analysis. The Level II analysis investigates these factors in more detail and attempts, where possible, to quantify the important variables.

After the direct costs of the test rules are ascertained, econometric and investment analyses are required to determine the impact of these costs on prices and quantities, which in turn, determine the impacts on production and employment. The result is consciously biased to present the "worst case" arising from the imposition of testing regulations.

CHAPTER III

LEVEL I ECONOMIC EVALUATION

CHLOROMETHANE (METHYL CHLORIDE)

III.A. Overview

III.A.1. Direct Costs of Testing

The proposed tests for chloromethane are shown below, together with their estimated costs;

Tests	Dollars (thousands)
Oncogenic (Hamster and Mouse; Inhalation)	$650 - $1,200
Teratology (Rabbit and Mouse; Inhalation)	50 - 100
TOTAL	$700 - $1,300

Based on: Cost Analysis Methodology and Protocol Estimates, TSCA Health Standards and FIFRA Guidelines. Draft Report submitted to U.S. Environmental Protection Agency, Office of Regulatory Analysis, by Enviro Control, Inc., April 3, 1980. Adjusted to correspond to proposed test rule.

Annualizing the total cost at 20 percent cost of capital for 20 years gives a range of $144,000 to $266,500. The broad range reflects considerable variability in cost among testing laboratories. This variability probably greatly outweighs variation among firms in cost of capital and investment time horizon.

III.A.2. Production and Producers

Domestic production of chloromethane was 478 million lbs. in 1977, and 454 million lbs. in 1978.[1,2] Preliminary production data for 1979 indicate that 449 million lbs. of chloromethane were produced[3], approximately the same volume as 1978. These production figures are understated since at least three companies (General Electric, Diamond Shamrock, and Vulcan Materials) produce other products from chloromethane in a continuous process which does not require separation of chloromethane from the process stream, and therefore do not report production to the International Trade Commission.[4]

Exports for chloromethane for 1978 amounted to 8.3 million lbs.[14] Exports of chloromethane cannot be compared with previous years since export data for this chemical were not published prior to 1978.

Import data for chloromethane are not reported separately by the government, but since total imports for all chlorinated hydrocarbons amounted to only 15.8 million lbs. in 1978,[14] chloromethane imports are probably not a significant factor.

The plant capacities for companies which produce chloromethane are given in Table III-1.

There are at least 13 producers of chloromethane with plants at 17 locations.[5,6,7,16] The total annual capacity of these plants is over 750 million lbs. Of these plants, three companies with more than 50 percent of total capacity are located in the Gulf Coast area of Texas and Louisiana. With

TABLE III-1: CHLOROMETHANE (METHYL CHLORIDE)

PRODUCTION SUMMARY

Production		Price ¢	Value of Shipments			Imports Million Lbs.	Exports
Year	Million Lbs.		Quantity Sold Million Lbs.	Sales Million $	Unit $		
1977	478	14	195.9	26.9	.14	Not Reported Separately	Not Reported Separately
1978	454	14	---	---	---	8.3	
1979	449(P)	--	---	---	---		

SOURCE: 1,2,3,15.

END USES OF CHLOROMETHANE

Percent Chloromethane Production	Used in Manufacture of	Projected Growth Rate	Substitute for Chloromethane
50 %	Silicones	10% - 12%	none
30-35%	Tetramethyllead and Tetramethylethyllead	negative	none
3- 4%	Herbicides	stable	----
3- 4%	Butyl Rubber	stable	----
3- 4%	Methylcellulose	stable	methyl alcohol
4%	Miscellaneous	stable	----

SOURCE: 4,6

MANUFACTURERS

Company	Location	Approx.1978 Capacity Million Lbs.	Percent Captive Use
Allied Chemical	Moundsville, WV.	25	
Ansul	Marinette, WI	n.a.	100%
Conoco Chemicals	Westlake, LA	100	
Diamond Shamrock	Belle, WV	> 50	100%
Dow Chemical	Plaquemine, LA	150	
	Freeport, TX	70	
Dow Corning	Carrolton, KY	20	
	Midland, MI	15	
E.I. DuPont	Deepwater, NJ	50	
Ethyl	Baton Rouge, LA	100	
	Louisville, KY	50	
General Electric	Waterford, NY	50	100%
Shell Chemical	Axis, AL	10	100%
Stauffer Chemical	Louisville, KY	15	
Union Carbide	Institute, WV	50	
Vulcan Materials	Geismar, LA	n.a.	100%
	Wichita, KS		
TOTAL		775	

SOURCE: 5,6,7,16.
n.a.=Not Available.

the exception of one plant in Kansas, the remaining chloromethane plants are located east of the Mississippi River in West Virginia, Kentucky, Michigan, New York, New Jersey, and Wisconsin.

It should be noted that some of the companies do not isolate chloromethane prior to using it as an intermediate in the manufacture of further chlorinated hydrocarbons such as methylene chloride (CH_2Cl_2), chloroform (CH_3Cl), and carbon tetrachloride (CCl_4).

III.A.3. Manufacturing Process

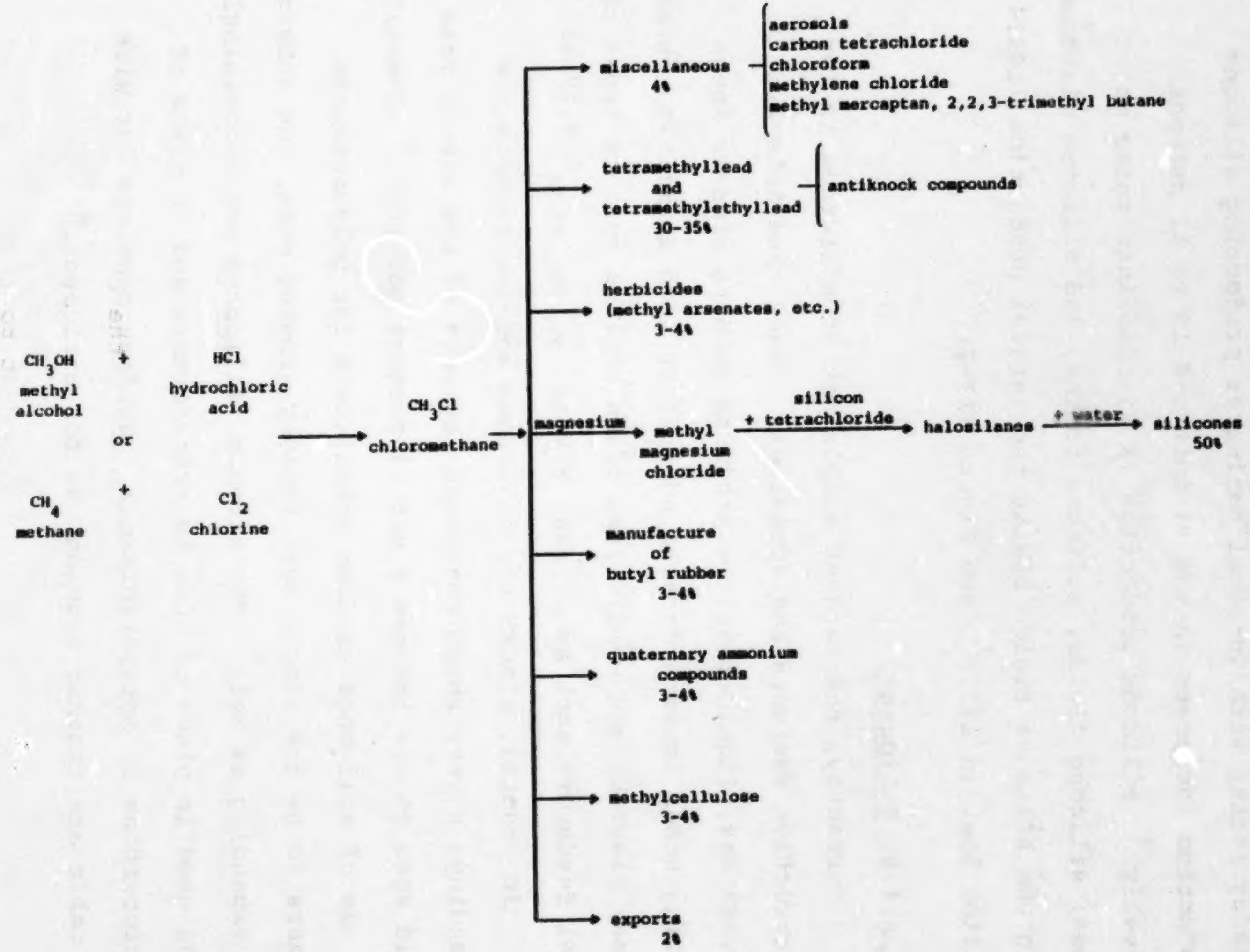
Chloromethane can be manufactured either by the hydrochlorination of methanol or by the direct chlorination of methane.[4] The vast majority of the present capacity is based on methanol as a starting material.[7] The reason for the almost universal use of the hydrochlorination of methanol process may be the availability and low price (6¢ per lb. in 1978) of synthetic methanol.[1,4]

III.A.4. Product Uses

Most methyl chloride production is used captively for the production of silicone fluids, silicone resins, silicone elastomers, chlorinated hydrocarbons, surfactants (surface active agents), lubricants, and as a catalyst carrier in the production of butyl rubber.

Figure III-1 shows the percentage of the chloromethane production which entered the manufacture of various products during 1978. Approximately 50 percent went to the manufacture

FIGURE III-1: END USES OF CHLOROMETHANE, 1978


CH_3OH
methyl
alcohol
+
HCl
hydrochloric
acid
or
CH_4
methane
+
Cl_2
chlorine
CH_3Cl
chloromethane
miscellaneous
4%
aerosols
carbon tetrachloride
chloroform
methylene chloride
methyl mercaptan, 2,2,3-trimethyl butane
tetramethyllead
and
tetramethylethyllead
30-35%
antiknock compounds
herbicides
(methyl arsenates, etc.)
3-4%
magnesium
methyl
magnesium
chloride
silicon
+ tetrachloride
halosilanes
+ water
silicones
50%
manufacture
of
butyl rubber
3-4%
quaternary ammonium
compounds
3-4%
methylcellulose
3-4%
exports
2%

SOURCE: 4,6,7,8,9,10,11

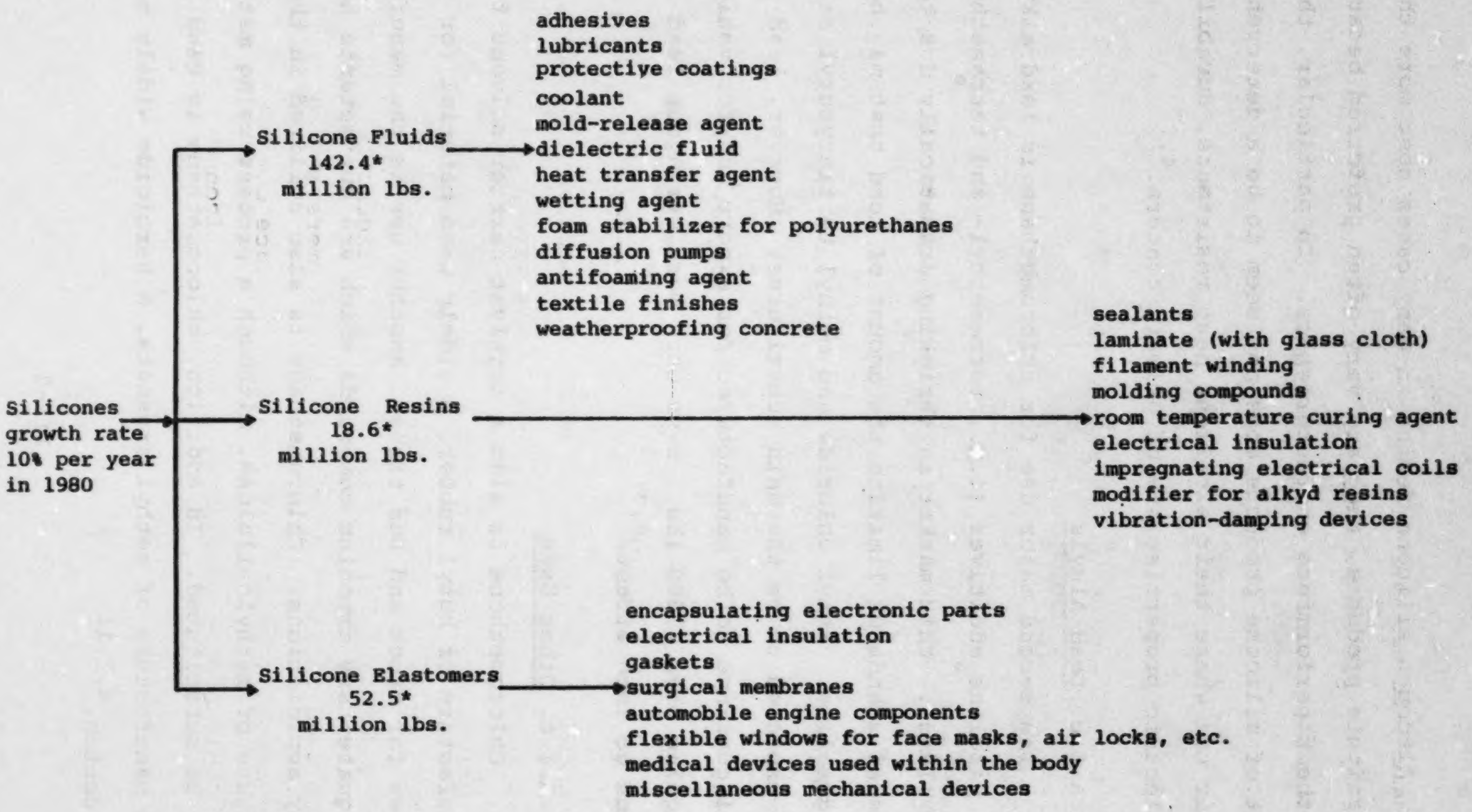
of halosilicanes which were, in turn, used for the manufacture of silicone (siloxanes and polysiloxanes).[4,6,7] This is a growing market with informal estimates projecting silicone production increases in the vicinity of 10 to 12 percent annually.[7] Silicone production is divided into three major types: silicone fluids, silicone resins, and silicone elastomers; with the silicone fluids having the largest production (142.4 million lbs. in 1977)[1] (see Figure III-2).

III.A.4.a. Silicones

Currently, the largest single use of silicones is for construction sealants and adhesives. These materials are solventless, liquid-reactive products used to produce long-lasting bonds between durable substrates such as metals, ceramics, glass, plastic, and wood. They often replace various types of metal fasteners such as screws, rivets, welds, etc.[8,9,10,11]

In general, almost all silicones end-use markets are expanding; a very rough consensus estimate of the growth rate would seem to lie between 8 and 14 percent per year.[7] Overall, the use of silicones as foam stabilizers for polyurethanes appears to be the single most rapidly growing area, but others are expanding as well. For example, silicones are increasingly being used in place of PCBs in transformers and in place of fluorocarbons in antiperspirants. Surface coatings for wire and cable are another growing use for silicones.[4,7]

FIGURE III-2: END USES OF SILICONES


Silicones
growth rate
10% per year
in 1980
Silicone Fluids
142.4*
million lbs.
adhesives
lubricants
protective coatings
coolant
mold-release agent
dielectric fluid
heat transfer agent
wetting agent
foam stabilizer for polyurethanes
diffusion pumps
antifoaming agent
textile finishes
weatherproofing concrete
Silicone Resins
18.6*
million lbs.
sealants
laminate (with glass cloth)
filament winding
molding compounds
room temperature curing agent
electrical insulation
impregnating electrical coils
modifier for alkyd resins
vibration-damping devices
Silicone Elastomers
52.5*
million lbs.
encapsulating electronic parts
electrical insulation
gaskets
surgical membranes
automobile engine components
flexible windows for face masks, air locks, etc.
medical devices used within the body
miscellaneous mechanical devices

*1977 Data from Synthetic Organic Chemicals, U.S. International Trade Commission.

Although silicone resins in many cases cost more than substitute products, they are very often preferred because of their performance characteristics. In particular, the cost of silicone products does not seem to be a deterrent to their use where their excellent heat resistance, durability, and dielectric properties are of primary concern.[4,7]

III.A.4.b. Lead Alkyls

The second major use for chloromethane is lead alkyls for gasoline additives (i.e., tetramethyl- and tetramethylethyllead). This market is shrinking dramatically due to Federal standards limiting the amount of lead that may be added to gasoline. Ethyl chloride and methyl tertiarybutyl ether are expected to be the main substitutes. However, lead alkyls will continue to be manufactured for export and for vehicles weighing over 6,500 lbs., even when more stringent lead limitations go into effect.[6,7]

III.A.4.c. Other Uses

Chloromethane is also a catalyst carrier solvent for the manufacture of butyl rubber, a widely used material for inner tubes for truck and bus tires. Another use is the manufacture of quaternary ammonium compounds which are surfactants having many applciations. Chloromethane is also utilized in the manufacture of methylcellulose, although a process using methanol may be substituted. In addition, chloromethane is used for the manufacture of methyl arsenate, a herbicide widely used on cotton.[6,7,11]

III.B. Potential for Economic Impact

As described in Chapter II, Economic Impact Methodology, a series of market characteristics are considered in assessing the potential impact of testing requirements on chloromethane. These are (1) demand sensitivity, (2) market expectations, (3) cost characteristics, and (4) industry structure.

III.B.1. Demand Sensitivity

The first factor of importance is demand sensitivity as approximated by the availability of substitutes in consumption. It is clear from the discussion above that the central market for consideration is that for silicones. While lead gasoline additives currently consume 30-35 percent of current production, this market might be seriously diminished for regulatory reasons other than those potentially imposed under TSCA and, thus, need not be considered here. Other uses amount to around ten percent, none of which merit significant Level I attention.

As can be seen from Figure III-2, silicones produced from chloromethane have a multitude of uses. While each use has available substitutes, they are in general, technically inferior. Silicones are often employed for their heat resistant properties and very few substitutes offer their physical and chemical characteristics. In the construction adhesive area, which provides the largest single market for silicones, these materials substitute not only for other materials, but for skilled labor as well. In such cases, demand is particularly insensitive to price. Over all, demand for silicones appears to be quite price insensitive, and thus, also the demand for chloromethane.

III.B.2. Market Expectations

Closely tied to the above observation is the clear optimism of the chemical industry regarding the future of silicone products. Uses for silicones are expanding, and the markets for almost every silicone use are growing rapidly. Silicones fluids, for example, have recently been found to make excellent mold-release agents and are expected to penetrate this important market rapidly. In addition, the increasing use of silicones as replacements for PCBs and fluorocarbons suggests rapid growth in the markets for silicones. As noted previously, the industry appears to expect an annual eight-to-ten percent growth rate in the silicones market.

III.B.3. Cost Characteristics

In terms of technological structure, the production of chloromethane is generally uniform. This is due to the prevalence of the methanol process in the production of chloromethane. As mentioned above, the widespread use of this process may be due to the availability and lower relative prices of the feedstocks used in this process, as well as the relative ease of handling the raw materials and control of the chemical reaction. It is not expected that the imposition of testing costs will alter this cost structure.

III.B.4. Industry Structure

Cost structure for the industry appears homogeneous, that is, it appears to vary little among firms. There are no unique factor inputs and the production process is simple and almost universally employed. Transportation costs are not significant. The existence of an entire range of plant sizes indicates that scale economies are not an important factor. Under such conditions, the existence of 13 producers would tend to signal presence of a competitive industry.

III.C. Conclusions

Although a competitive industry with low transportation costs would often be regarded as possessing potential for economic impact and, thus, a candidate for further analysis, the insensitivity of demand with respect to price changes in the silicones market and the extremely optimistic industry outlook point to very minor repercussions as a result of the imposition of testing requirements.

This conclusion is reinforced considerably when estimated direct testing costs are annualized on a per-pound basis. If annual production remains at a 450 million pound level (a very conservative assumption), the additional cost will be only .06 cents per pound, certainly an extremely small amount by any standard and, in this case, amounting to only .4 percent of current price. For this reason, no production and employment effects are anticipated.

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CHAPTER IV

ECONOMIC EVALUATION: CHLOROBENZENES

IV.A. Level I. Analysis

IV.A.1. Overview

The chlorobenzene group of chemicals totals 12 compounds, of which 11 are considered under the proposed test rule.* These 11 compounds are as follows:

Monochlorobenzene;
o-Dichlorobenzene, (1,2-);
p-Dichlorobenzene, (1,4-);
m-Dichlorobenzene, (1,3-);
1,2,4-Trichlorobenzene;
1,2,3-Trichlorobenzene;
1,3,5-Trichlorobenzene;
1,2,4,5-Tetrachlorobenzene;
1,2,3,4-Tetrachlorobenzene;
1,2,3,5-Tetrachlorobenzene; and
Pentachlorobenzene.

Commercially, monochlorobenzenes and dichlorobenzenes are manufactured from chlorine and benzene feedstocks in a joint process where the relative amounts of monochlorobenzene, o-, and p-dichlorobenzenes can be partially altered by choice of process conditions. Trichlorobenzenes, tetrachlorobenzenes, and pentachlorobenzenes are produced sequentially.

---

*Hexachlorobenzene is not considered in the test rule.

Chlorobenzenes are currently produced domestically by six companies, are imported by several others, and processed by an undetermined number of firms. The overall production capacity probably exceeds 600 million lbs. per year. Chlorobenzenes are primarily used as organic intermediates and as solvents in chemical processes.

IV.A.1.a. Direct Testing Costs

The direct costs of conducting required tests are those costs borne specifically in the laboratory accomplishment of the tests. In addition to these laboratory-related costs, manufacturers and processors will also bear other indirect costs of an administrative nature in connection with overall TSCA Section 4 compliance.

The costs estimated here for the purpose of impact analysis are those of meeting testing requirements. Actual costs may be greater to the extent that optional testing is performed, but such optional testing is not considered to be a true cost of the regulation. In particular, it is assumed that an industry reimbursement system will be successfully implemented, and thus, that required tests will be performed only once for the benefit of the entire group.

It is recognized that the actual costs of any testing scheme can vary substantially in practice for any chemical tested, depending upon a number of factors; including for example, the laboratory performing the test, number of dose levels, species, routes of exposure, extent of pathology conducted, duration of tests, labor productivity, and wage rates. Thus, for this analysis, a range of costs was calculated.[34] Such a range should bracket the actual expected value of the direct costs. Calculations were performed by Borriston Laboratories, a commercial testing laboratory owned by Enviro Control, Inc. under contract to MATHTECH, Inc.

Under the proposed regulation, the 11 chlorobenzene compounds specified for testing can be grouped according to the level of chlorination. These groups are:

- Monochlorobenzene
- Dichlorobenzene: 1,2-(ortho); 1,4-(para); 1,3-(meta)
- Trichlorobenzene: 1,2,4-; 1,2,3-; 1,3,5-
- Tetrachlorobenzene: 1,2,4,5-; 1,2,3,4-; 1,2,3,5-
- Pentachlorobenzene

These compounds will be subjected to a testing regime, whereby a number of tests are specified on six of the chemicals. Further tests may be required if positive results from the initial set of tests indicate a need for further testing. The set of tests varies for some of the chlorobenzenes but generally is made up of the following:

- Subchronic;
- Oncogenicity;
- Structural teratology;
- Reproductive.

Table IV-1 shows the range of costs for the specified tests by chlorination level. It should be noted that the proposed test rule specifies tests and protocols only for the six "representative sample" chlorobenzenes--monochlorobenzene, ortho- and para-dichlorobenzene, 1,2,4-trichlorobenzene, 1,2,4,5-tetrachlorobenzene, and pentachlorobenzene. In order to analyze the economics of the alternative approaches to testing, a worst case analysis has been conducted, assuming the imposition of testing requirements for the additional five compounds. Table IV-1 costs cannot be totaled since they do not reflect the specific reimbursement and exemption alternative approaches. These will be examined in Section IV.B.5. et seq.

Differing costs among the various compounds for the same tests reflect the different species and application requirements of the test rule. Exemptions for NCI testing have been included. Note, as mentioned above, that this total includes neither indirect costs nor the value of tests that could be additionally required. These adjustments will be made on a general basis as part of overall impact assessment.

IV.A.1.b. Production Process

Chlorobenzenes are produced by the chlorination of benzene in the presence of various catalysts. Commercial production of the mono-, di-, tri-, tetra- and pentachlorobenzenes takes place in a series of chlorination reactions, each of which is a chlorination of the previous chlorination products in the series.

TABLE IV-1: ESTIMATED TEST COSTS, CHLOROBENZENES

($ thousands)

Compound	Oncogenic Effects	Teratogenic Effects	Reproductive Effects	Subchronic Effects
Monochlorobenzene	---[a]	$ 50-100	$110-220	$ 32-96
Dichlorobenzene	---[a]	50-100	110-220	32-96
Trichlorobenzene	$328-983	27- 81	57-171[b]	28-84
Tetrachlorobenzene	328-983	27- 81	57-171	28-84
Pentachlorobenzene	328-983	---	57-171	28-84

SOURCE: Cost Analysis Methodology and Protocol Estimates, TSCA Health Standards and FIFRA Guidelines. Draft Report submitted to U.S. Environmental Protection Agency, Office of Regulatory Analysis, by Enviro Control, Inc., April 3, 1980. Adjusted to correspond to proposed test rule.

[a] Testing for oncogenic effects for monochlorobenzene and ortho- and para-dichlrobenzene will be carried out by the National Cancer Institute and is exempted from the test rule. Oncogenic effects are not exempted for meta-dichlorobenzene. This cost would be $650-1,200 thousand.

[b] 1,2,4-trichlorobenzene is exempted from reproduction effects testing.

FIGURE IV-1a: MONOCHLOROBENZENE AND
o- and p-DICHLOROBENZENES
PRODUCTION SCHEME

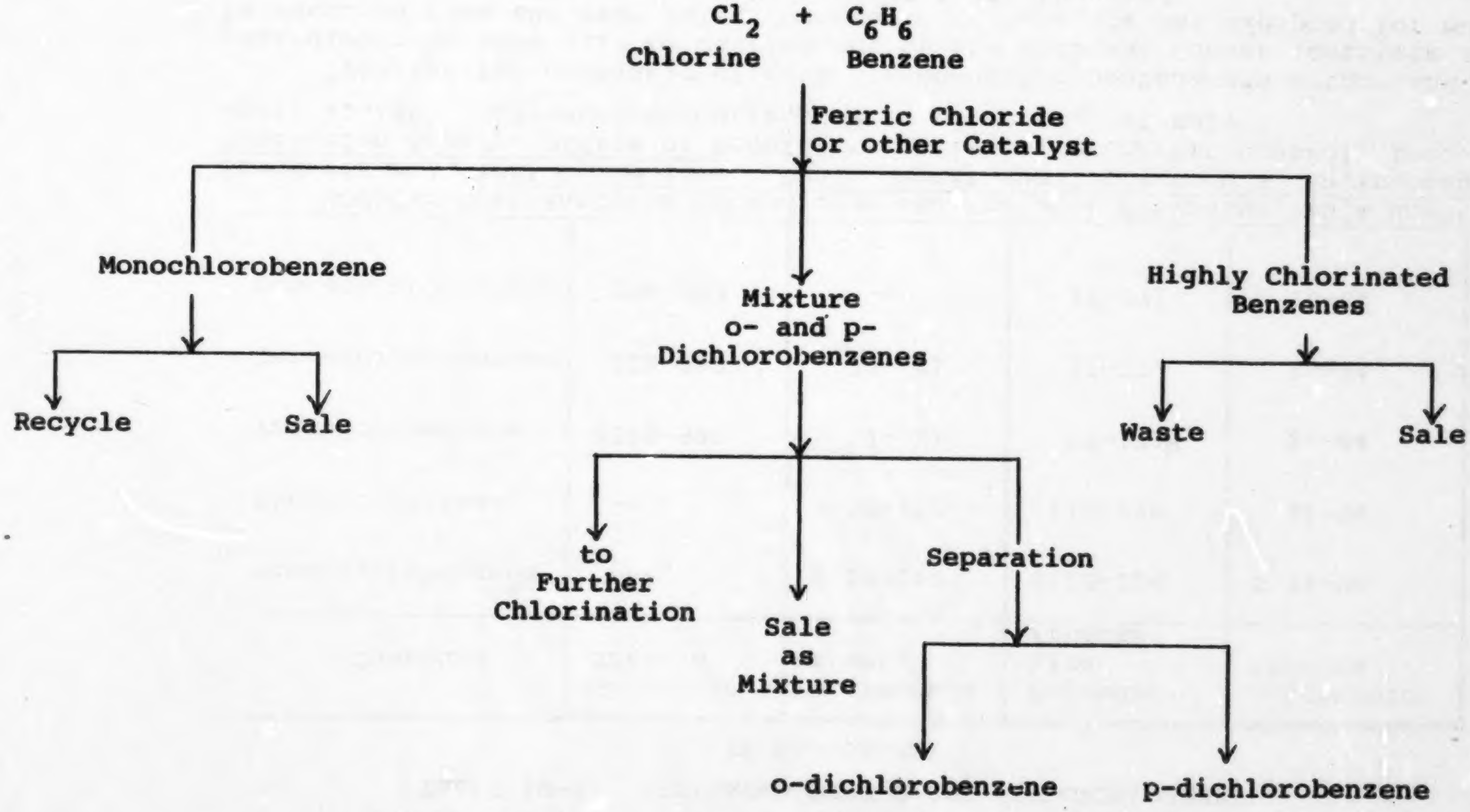

Cl_2 + C_6H_6
Chlorine
Benzene
Ferric Chloride or other Catalyst
Monochlorobenzene
Recycle
Sale
Mixture o- and p-Dichlorobenzenes
to Further Chlorination
Sale as Mixture
Separation
o-dichlorobenzene
p-dichlorobenzene
Highly Chlorinated Benzenes
Waste
Sale

FIGURE IV-1b: TRICHLOROBENZENES PRODUCTION SCHEME

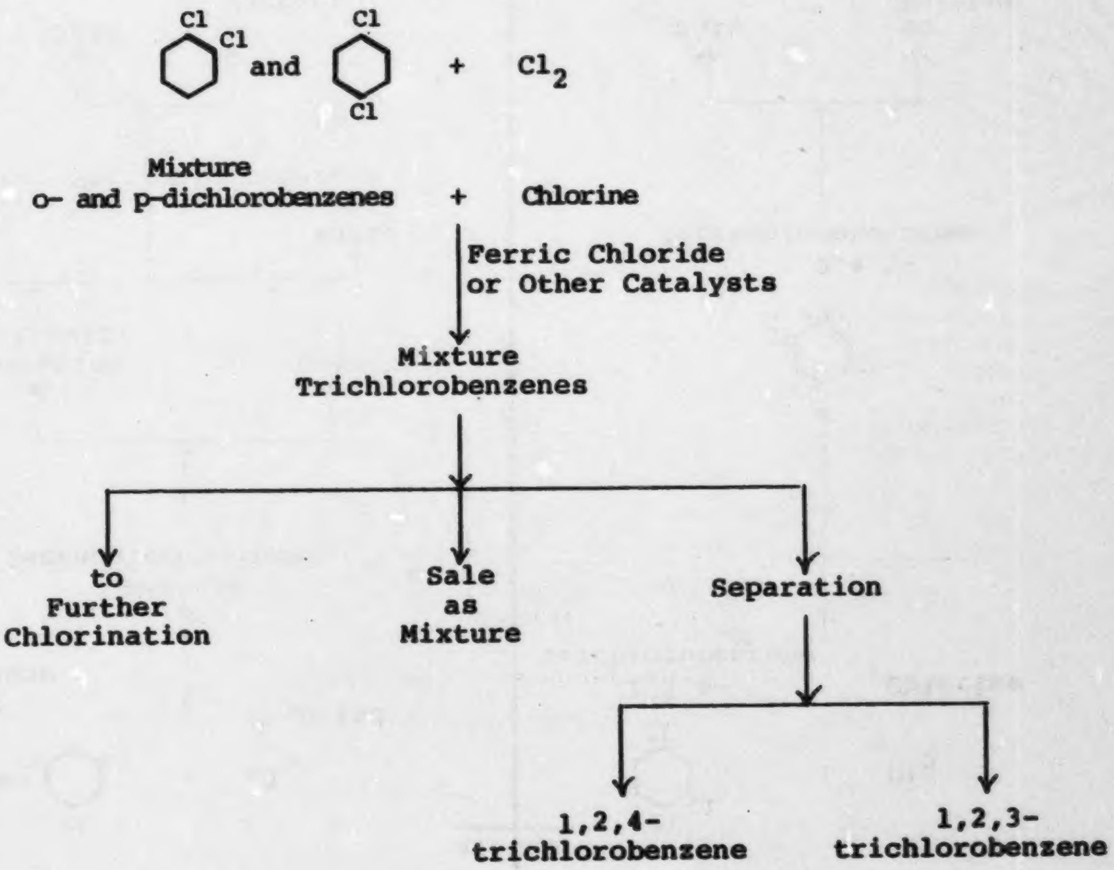

Cl
Cl
and
Cl
Cl
+
Cl_2
Mixture
o- and p-dichlorobenzenes
+
Chlorine
Ferric Chloride
or Other Catalysts
Mixture
Trichlorobenzenes
to
Further
Chlorination
Sale
as
Mixture
Separation
1,2,4-
trichlorobenzene
1,2,3-
trichlorobenzene

FIGURE IV-1c: TETRACHLOROBENZENES PRODUCTION SCHEME

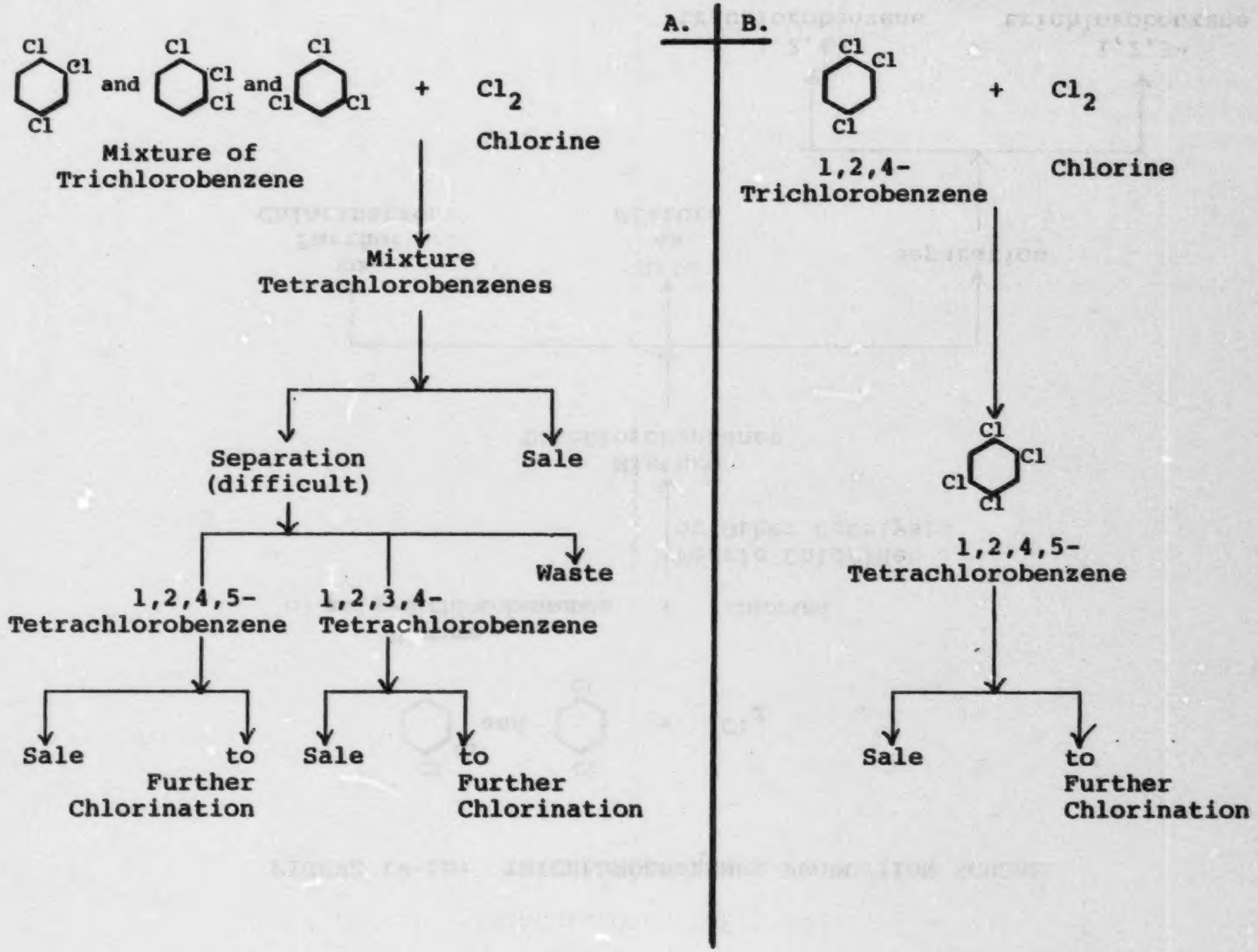
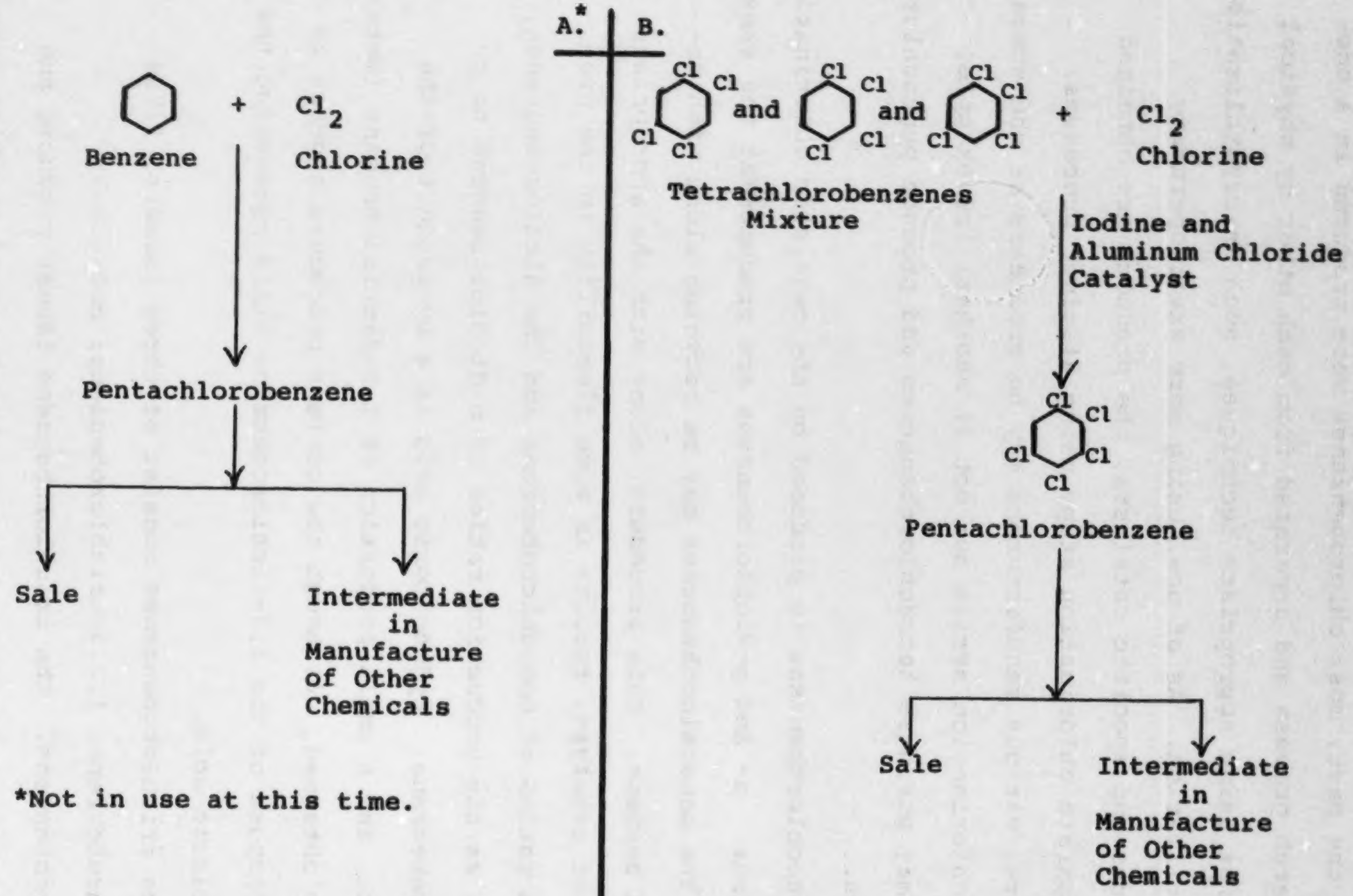

A.
Cl
Cl
Cl
and
Cl
Cl
Cl
and
Cl
Cl
Cl
+
Cl_2
Chlorine
Mixture of Trichlorobenzene
Mixture Tetrachlorobenzenes
Separation (difficult)
Sale
Waste
1,2,4,5-Tetrachlorobenzene
1,2,3,4-Tetrachlorobenzene
Sale
to Further Chlorination
Sale
to Further Chlorination
B.
Cl
Cl
Cl
+
Cl_2
1,2,4-Trichlorobenzene
Chlorine
Cl
Cl
Cl
Cl
1,2,4,5-Tetrachlorobenzene
Sale
to Further Chlorination

FIGURE IV-1d: PENTACHLOROBENZENE PRODUCTION SCHEME


A.*
B.
Benzene
+
Cl2
Chlorine
Pentachlorobenzene
Sale
Intermediate in Manufacture of Other Chemicals
Cl
and
+
Tetrachlorobenzenes Mixture
Iodine and Aluminum Chloride Catalyst
Pentachlorobenzene
Sale
Intermediate in Manufacture of Other Chemicals

*Not in use at this time.

In the past, most chlorobenzenes were produced in a one-step, batch process and separated from each other by physical properties using appropriate techniques, such as crystalization and distillation. As of now, using more exact operating conditions and specific catalysts, the products are obtained from separate chlorination steps using distinct processes. Therefore, various manufacturers may be producers at one stage in the chlorination series but not at another; for example, a firm may purchase tetrachlorobenzenes and produce pentachlorobenzenes.

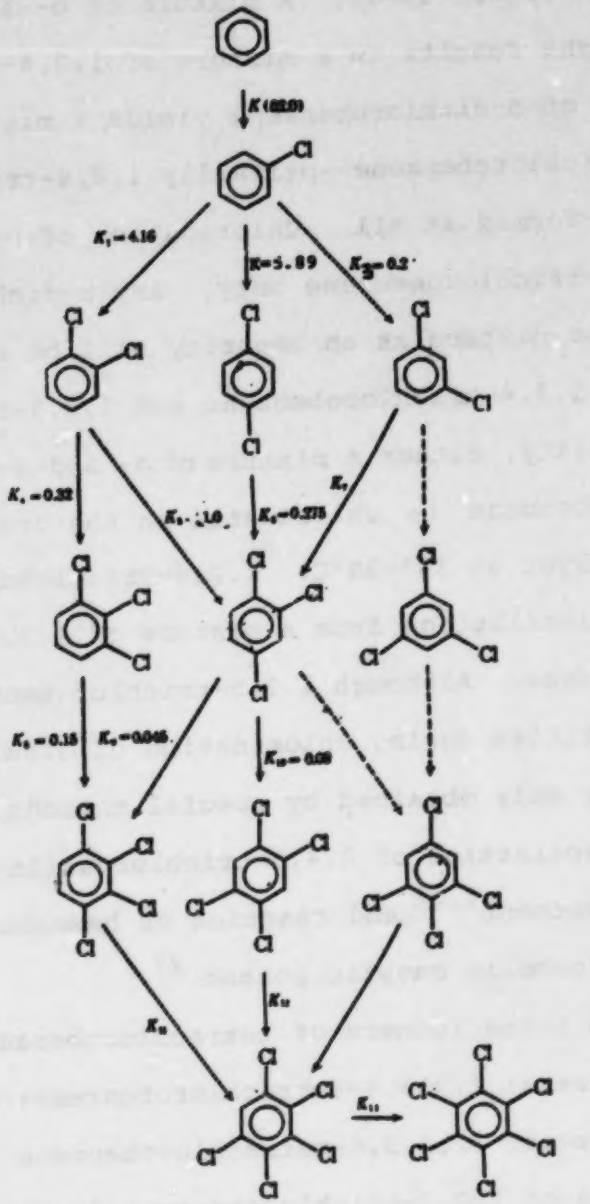
Monochlorobenzene is produced by the catalytic chlorination of benzene. o- And p-Dichlorobenzene are produced at the same time. The monochlorobenzenes may be recycled along with unreacted benzene. This procedure, along with the appropriate choice of catalyst, results in some flexibility in the production ratios of monochlorobenzene and the dichlorobenzenes, as well as the production ratios of o-dichlorobenzene to p-dichlorobenzene. Hydrochloric acid is a by-product of the reaction, and a small proportion of 1,3-dichlorobenzene (meta) is also obtained, although the current procedure appears to be to dispose of the 1,3-dichlorobenzene while recovering the hydrochloric acid.

The trichlorobenzenes consist of three isomers; 1,2,4-trichlorobenzene; 1,2,3-trichlorobenzene; and 1,3,5-trichlorobenzene. The trichlorobenzene isomer produced and the quantity produced depend upon the choice of starting (raw) material for the chlorination reaction, and the relative rate of reaction (K values) for the specific chemical reactions involved (see Figure IV-2). A mixture of o- and p-dichlorobenzene results in a mixture of 1,2,4- and 1,2,3-; and chlorination of o-dichlorobenzene yields a mixture of 1,2,3- and 1,2,4-trichlorobenzene--primarily 1,2,4-trichlorobenzene. No 1,3,5- is formed at all. Chlorination of p-dichlorobenzene yields 1,2,4-trichlorobenzene only. Any m-dichlorobenzene present in the mixture as an impurity will be chlorinated to a mixture of 1,2,4-trichlorobenzene and 1,3,5-trichlorobenzene.[1]

In actuality, either a mixture of o- and p-dichlorobenzenes or o-dichlorobenzene is chlorinated in the presence of ferric chloride catalyst at 25°-30°C. 1,2,4-Trichlorobenzene is obtained by distillation from a mixture of 1,2,3- and 1,2,4-trichlorobenzenes. Although 1,3,5-trichlorobenzene is formed in small quantities during chlorination of dichlorobenzenes, it is normally only obtained by special methods. Two of these are diazotization of 2,4,6-trichloroaniline followed by alcohol treatment[1,28] and reaction of hexachlorobenzene and alcoholic caustic potash.[27]

There are three isomers of tetrachlorobenzene: 1,2,4,5-tetrachlorobenzene; 1,2,3,4-tetrachlorobenzene; and 1,2,3,5-tetrachlorobenzene. 1,2,3,4-tetrachlorobenzene is produced by chlorination of 1,2,3-trichlorobenzene in the presence of a catalyst. 1,2,4,5-Tetrachlorobenzene is produced by chlorination of 1,2,4-trichlorobenzene using iodine and antimony chloride catalyst.[1]

FIGURE IV-2: SEQUENTIAL REACTIONS SHOWING RELATIVE RATES IN THE LIQUID CHLORINATION OF BENZENE


K (82.0)
Cl
K₁ = 4.16
K = 5.89
K₃ = 0.2
K₄ = 0.32
K₅ = 1.0
K₆ = 0.275
K₇
K₈ = 0.15
K₉ = 0.045
K₁₀ = 0.09
K₁₁
K₁₂
K₁₃

SOURCE: Kirk-Othmer Encyclopedia of Chemical Technology, Third Edition, Volume 5, 1979, p. 801.

1,2,3,5-Tetrachlorobenzene may be produced by chlorination of 1,3,5-trichlorobenzene using an aluminum amalgam as a catalyst. It is believed that this process has not been used commercially. In fact, it is believed that this isomer is presently only manufactured as an impurity and disposed of as waste.[2]

Pentachlorobenzene is produced by chlorination of tetrachlorobenzenes in the presence of a catalyst.

IV.A.1.c. Production and Manufacturers

Table IV-2 gives production data for the various chlorobenzenes.[2,3,4,5] The data are understated because quantitites used internally are not fully reported. Current manufacturers of chlorobenzenes, along with plant locations and capacities, are listed in Table IV-3. Three manufacturers, Dow, Monsanto, and Standard Chlorine, account for more than 75 percent of chlorobenzenes capacity.

IV.A.1.c.1 Monochlorobenzene

Monochlorobenzene is the highest volume product in the chlorobenzene group, although production has generally been declining over the past decade. Statistics for 1977 and 1978, as shown in Table IV-2, indicate that production of monochlorobenzene dropped from 325.5 million lbs. in 1977 to 295.4 million lbs. in 1978, a decrease of almost ten percent. Cumulative production, as of September 1979, was 249 million lbs. indicating a small recovery. Total production for 1979 is estimated to be 325.5 million lbs--equal to the 1977 production levels.[5]

TABLE IV-2: PRODUCTION SUMMARY, LOWER CHLOROBENZENES

MONOCHLOROBENZENE

Production		Price[c]		Sales			Exports	Imports
Year	Million lbs.	¢/lb. low	¢/lb. high	Quantity (Million lbs.)	Million $	$/lb.	Million lbs.	Million lbs.
1977	325.5	26¢	29¢	174.8	35.1	.20	Not reported separately	1.05
1978	295.4	26¢	29¢	96.4	21.2	.22		.98

o-DICHLOROBENZENE

Production		Price[c]	Sales			Exports[b]	Imports[a]
Year	Million lbs.	¢/lb.	Quantity (Million lbs)	Million $	$/lb.	Million lbs.	Million lbs.
1977	47.4	27¢	55.7	15.3	.27	7.7	.86
1978	41.1	26¢	44.0	11.8	.27	20.0[b]	---

p-DICHLOROBENZENE

Production		Price[c]	Sales			Exports[b]	Imports[a]
Year	Million lbs.	¢/lb.	Quantity (Million lbs.)	Million $	$/lb.	Million lbs.	Million lbs.
1977	65.1	23¢	62.0	14.2	.23	Not reported separately	---
1978	41.2	27¢	38.1	10.3	.27		.02

SOURCE: Imports: FT135, U.S. Dept. of Commerce and Imports of Benzenoid Chemicals, USITC; Exports: FT410, U.S. Dept. of Commerce.

[a] 1977 Imports of o-, p-dichlorobenzene mixture were .33 million lbs.; 1978 imports of o-, p-dichlorobenzene mixture were 0.5 million lbs.

[b] Exports are reported for o- and p-dichlorobenzene combined.

[c] Asking price for early January (Chemical Marketing Reporter).

TABLE IV-3: MANUFACTURERS OF CHLOROBENZENES

Company	Location	1978 Capacity, million lbs.					
		mono*	o*	p*	1,2,4 tri*	1,2,4,5 tetra*	penta*
Dow Chemical	Midland, MI	220	30	30	x	x	
Monsanto	Sauget, IL	150	x	x			
Montrose Chemical Corp. (50% owned by Stauffer, 50% by Chris Craft)	Henderson, NV	70					
Olin Corporation	McIntosh, AL						x
PPG Industries	Natrium, WV	90	20	30	x		
Specialty Organics Inc.	Irwindale, CA (processor)		2	2			
Standard Chlorine Chemical Co., Inc.	Delaware City, DE	150	50	75	x	x	
	Kearny, NH (processor)		16	15			
TOTAL		680	118	152			

SOURCES: SRI Directory Chemical Producers, 1979, and Synthetic Organic Chemicals, International Trade Commission, 1978.

* mono=monochlorobenzene; o=ortho-dichlorobenzene; p=para-dichlorobenzene; 1,2,4 tri=1,2,4-trichlorobenzene; 1,2,4,5 tetra=1,2,4,5-tetrachlorobenzene; penta=pentachlorobenzene.

[x] Information on plant capacity is not available.

Dow Chemical, PPG Industries, Monsanto, Montrose, and Standard Chlorine Chemical Co. are producers of monochlorobenzenes, with total available capacity in excess of 680 million lbs. per year. Vertac, Allied, and Dover Chemical were formerly important producers of monochlorobenzenes. All three have now left the market, the latter two since 1977.[6,7] Others are also believed to have ceased production, indicating a clear deficiency in demand relative to production potential.

IV.A.1.c.2. Dichlorobenzenes

The second highest volume group of chlorobenzenes is the dichlorobenzenes. Although the ratio of total production of the o- and p-dichlorobenzenes has fluctuated widely, the unit value of o-dichlorobenzene has exceeded that for p-dichlorobenzene in recent years.

As a result of the joint nature of the chlorobenzenes production process, all producers of monochlorobenzene--except Montrose--also produce o- and p-dichlorobenzenes. Two companies, Specialty Organics, Inc. in California and Standard Chlorine Chemical Company in Delaware, do not produce monochlorobenzene, but instead resolve o- and p-dichlorobenzene mixtures into their component isomers.

Production of o-dichlorobenzene was 47.4 million lbs. in 1977[5] and 41.1 million lbs. in 1978;[35] while p-dichlorobenzene production was 65.1 million lbs. and 41.2 million lbs. in 1977[5] and 1978[35] respectively. Data for 1979 is not yet available.

IV.A.1.c.3 Trichlorobenzenes

An estimated 45 million lbs of trichlorobenzenes were produced in 1976, with production levels off considerably during 1978 and 1979.[3] At present, the International Trade Commission lists only Dow Chemical Company and Standard Chlorine Chemical Company as producers of 1,2,4-trichlorobenzene; and PPG Industries along with Standard Chlorine as producers of mixed 1,2,3- and 1,2,4-trichlorobenzenes.

Present annual production of trichlorobenzenes is estimated at 15 to 20 million lbs. per year by Dow Chemical.[21] Production increased from 9.3 million lbs. in 1970 to 28.3 million lbs. in 1973. Production data is not available from the ITC for 1974 to present. However, based upon the isomer composition of 1,2,3- and 1,2,4-trichlorobenzenes mixtures, and information from Dow Chemical,[20,21] MATHTECH estimates of the isomers within the total trichlorobenzene production for 1978 have been made. They are 1,2,4-trichlorobenzene, 16 million lbs.; 1,2,3-trichlorobenzene, four million lbs.; and 1,3,5-trichlorobenzenes, six thousand lbs.

IV.A.1.c.4 Tetrachlorobenzenes

For tetrachlorobenzenes, it is estimated that the production of ten million lbs. of tetrachlorobenzenes includes six million lbs. of 1,2,4,5-tetrachlorobenzene. The quantity of 1,2,3,5-isomer formed as a by-product is estimated from Dow data and specific reaction rates to be approximately three million lbs. per year.[20,21]

Production of tetrachlorobenzenes appears to be down from the reported 1973 consumption of 18 million lbs. of 1,2,4,5-tetrachlorobenzene.[20,21]

According to the TSCA Inventory there are two producers of tetrachlorobenzenes.

IV.A.1.c.5 Pentachlorobenzene

Production for pentachlorobenzene is reportedly five to ten million lbs. per year. This chemical is used for the manufacture of pentachloronitrobenzene (PCNB). Production data for PCNB is included in a composite of data for 11 cyclic fungicides and is not available separately.[5] The Olin Corporation is the only domestic manufacturer of pentachlorobenzene and uses it captively.

IV.A.1.d. Imports and Exports

Exports are not reported separately for o- and p-dichlorobenzenes. As a group, 20.8 million lbs., valued at $6.2 million, were exported worldwide in 1978, with 85 percent shipped to Canada, Mexico, and Japan.[8] Exports accounted for about 25 percent of the total United States production of o- and p-dichlorobenzenes in 1978.

Imports of chlorobenzenes are tabulated in Table IV-4 for years 1974 to 1978. The total imports of all isomers of chlorobenzenes were 4.6 million lbs., valued at $1.3 million in 1978. This was up from 2.3 million lbs. in 1977.[8] Although combined imports of chlorobenzenes were up in 1978 over 1977, imports of

TABLE IV-4: IMPORTS OF CHLOROBENZENES (Lbs.)

	Monochlorobenzene	o-Dichlorobenzene	o- and p-Dichlorobenzene Mixture	p-Dichlorobenzene	m-Dichlorobenzene	1,2,3- (and 1,2,4 Trichlorobenzene	1,2,4-Trichlorobenzene	1,3,5-Trichlorobenzene	Trichlorobenzene (Mixture)	Tetra-Chlorobenzene	Penta-Chlorobenzene	TOTAL Chlorobenzene Imports
1974	1,485,106	1,631,404	none reported	—	31,006	—	2,770,245	21,525	940,715 (mixture)	1,467,819	—	8,347,820
1975	8,373,478	110,230	2,608,238	—	6,506	3,912,144	1,934,578	33,680	—	79,366	—	17,058,220
1976	6,185,753	887,375	855,370	—	4,851	266,990	—	9,460	—	39,683	—	8,249,482
1977	1,053,402	864,655	331,390	—	25,575	6,614	—	26,655	—	39,683	—	2,348,074
1978	982,957	none reported	50,000	24,030	106,021	1,102	—	—	2,074,151	1,371,261	—	4,609,522

SOURCES: References 12 through 16.

o- and p-dichlorobenzenes and trichlorobenzenes were down. A large part of the increase in combined imports is attributed to an increase of 1,2,4,5-tetrachlorobenzene imports, up from approximately 39 thousand lbs. in 1977 to 1.4 million in 1978; and an increase in imports of 1,3-dichlorobenzene. There is no indication that pentachlorobenzene is currently being imported.[12,16]

IV.A.1.e. Product Uses (See Tables IV-5a through f.)

IV.A.1.e.1. Monochlorobenzene

Monochlorobenzene is used primarily in the manufacture of organic intermediates for dyes and herbicides, and as a solvent in pesticide and degreasing formulations. In the past, monochlorobenzene was an important raw material for the manufacture of phenol and DDT. However, in recent years monochlorobenzene production has declined as phenol producers have shifted to less expensive cumene as a raw material and as the use of DDT (a downstream product of monochlorobenzene[1,3]) has become severely restricted. In addition, imports recently have made considerable inroads into the domestic benzenoid dye market.

The use of monochlorobenzene and o-dichlorobenzene as a solvent carrier in the manufacture of isocyanates is expected to increase. Isocyanates are used in the manufacture of polyurethanes, and polyurethane production is predicted to be 7.5 percent greater in 1979 than in 1978.[9] Also, Rubicon Chemicals is expected to bring onstream a new plant for

TABLE IV-5a: USES OF MONOCHLOROBENZENE

Percent MONOCHLOROBENZENE Production	Usage	Growth Rate	Substitute for MONOCHLOROBENZENE
60%	Organic Intermediate (dyes, organophosphorous chemicals, parathion, and o- and p-dichloronitrobenzene)	static	none
29%	Solvent manufacture diisodyanate (polyurethanes, phenol formaldehyde resin formulations, bonding rubber to nylon and rayon)	increasing 1-2%	o-dichlorobenzene
30-50%	Solvent (degreasing, pesticides)**	static	perchloroethylene in degreasing formulations
1%	DDT (export and emergency only)	static	none
10%	DPO (diphenyl oxide)		

SOURCES: References 20 and 4.

** Information in parentheses indicates areas of manufacture or end-use of product obtained subsequent to use of o-dichlorobenzene.

TABLE IV-5b: USES OF o-DICHLOROBENZENE

Percent o-DICHLOROBENZENE Production	Usage	Growth Rate	Substitute for o-DICHLOROBENZENE
65%	Organic intermediates (3,4-dichloroaniline, urea herbicides)**	static or declining	
15%	Solvent manufacture toluene diisocyanates (polyurethanes, cross-linking agent for nylong)	increasing 1-2%	monochlorobenzene
10%	Miscellaneous solvents	static	industrial solvents, perchloroethylene, etc., nitrobenzene in some processes.
5%	Dyestuff manufacture		
5%	Fumigants and insecticides	static	none

SOURCES: References 20, 4, 26.

** Information in parentheses indicates areas of manufacture or end-use of product obtained subsequent to use of o-dichlorobenzene.

TABLE IV-5c: USES OF p-DICHLOROBENZENE

Percent p-DICHLOROBENZENE Production	Usage	Growth Rate	Substitute for p-DICHLOROBENZENE
50%	Space deodorant	static	---
30%	Moth control	statis	naphthalene
10%	Organic intermediates (pesticides, pharmaceuticals, other organic intermediates)**	static	none
---	Soil fumigant		
10%	PPS - Polyphenyl Sulfide		

SOURCES: References 25, 27, 21, 20.

** Information in parentheses indicates areas of manufacture or end-use of product obtained subsequent to use of o-dichlorobenzene.

TABLE IV- 5d: USES OF 1,2,4- and 1,2,3-TRICHLOROBENZENE

Percent 1,2,4- and 1,2,3-TRICHLOROBENZENE Production	Usage	Growth Rate	Substitute for TRICHLOROBENZENES
50-60%	Organic intermediates (Tetrachlorobenzenes, dyes)**	declining-to-static	none
20-30%	Dye carrier		---
5-10%	Synthetic transformer oils and dielectric fluids		other dielectric fluids such as jydrocarbon oils, silicone oils, etc.
5-10%	Solvent in chemical manufacture		---

SOURCES: Refernces 20, 21, 4.

** Information in parentheses indicates areas of manufacture or end-use of product obtained subsequent to use of o-dichlorobenzene.

TABLE IV-5e : USES OF 1,2,4,5-TETRACHLOROBENZENE

Percent 1,2,4,5-TETRACHLOROBENZENE Production	Usage	Growth Rate	Substitute for 1,2,4,5-TETRACHLOROBENZENE
100%*	Pentachlorobenzene	----	none

*Estimates compiled from various sources.
SOURCES: Reference 31.

TABLE IV-5f: USES OF PENTACHLOROBENZENES

Percent PENTACHLOROBENZENES Production	Usage	Growth Rate	Substitute for PENTACHLOROBENZENES
100%*	Pentachloronitrobenzene (fungicide, slime preventor)**	?	none

SOURCES: References 6, 21, 31.

**Information in parenthesis indicates end-use of pentachloronitrobenzene.

MDI (diphenylmethane diisocyanate) with a capacity of 25 million lbs. in late 1980.[10] This plant will require either monochlorobenzene or o-dichlorobenzene for use as a solvent in the production process.

IV.A.1.e.2. o-Dichlorobenzene

o-Dichlorobenzene is used primarily as an organic intermediate for the production of amide (propanil) and urea herbicides (diuron, neburon). The main substitute for propanil (nine million lbs. in 1975) is the thiocarbamate herbicies, molinate.[11]

Dyes currently made from o-dichlorobenzene are C.I. Mordant Red 27, D.I. Direct Blue 108, and C.I. Direct Violet 54. At present, there is no substitute for o-dichlorobenzene in the manufacture of C.I. Mordant Red 27. However, a process using nitrobenzene may be used in the production of C.I. Direct Violet 54, and D.I. Direct Blue 108 can also be produced by a process not requiring o-dichlorobenzene.[11]

IV.A.1.e.3. p-Dichlorobenzene

p-Dichlorobenzene is mainly used as a space deodorant, where o-dichlorobenzene may be a substitute, and for moth control, where it has entered markets formerly dominated by naphthalene. If synthetic fibers continue to penetrate wool markets, then a decline in the consumption of p-dichlorobenzene for moth control might be expected.[3]

IV.A.1.e.4. Trichlorobenzenes

1,2,4-Trichlorobenzene and 1,2,3-trichlorobenzene are used primarily as organic intermediates in the production of dyes and pesticides (for example, 2,4-D). The trichlorobenzenes are also used extensively as dye carriers and find some use as solvents in chemical processes and as dielectric fluids.[20,21,4]

IV.A.1.e.5. Tetrachlorobenzenes

At present all 1,2,4,5-tetrachlorobenzene production is used for the manufacture of pentachlorobenzene. In the past the primary use was for manufacture of herbicides 2,4,5-T and silvex. However, recent restrictions on uses of 2,4,5-T and silvex have caused this market to decline significantly.

IV.A.1.e.6. Pentachlorobenzene

Pentachlorobenzene is used only for the production of pentachloronitrobenzene which is used as a fungicide and slime preventor.[11]

Although there is no substitute for pentachlorobenzene in the production of pentachloronitrobenzene (PCNB), there are numerous fungicides presently manufactured, some of which are likely to be substitutes for pentachloronitrobenzene.[5] However, PCNB is a broad spectrum fungicide and has found increasing use since the early 1970s. This may be due to the restriction on use of mercury fungicides which occurred at about the same time.[18,19,23,24]

IV.A.2. Potential for Economic Impact

As described in Chapter II, Economic Impact Methodology, a series of market characteristics are considered in assessing the potential impact of testing requirements on chlorobenzenes. These are (1) demand sensitivity, (2) market expectations, (3) cost characteristics, and (4) industry structure.

IV.A.2.a. Demand Sensitivity

The first factor of importance is demand sensitivity as approximated by the availability of substitutes in consumption. The largest use for monochlorobenzene--the highest volume chlorobenzene--is in organic intermediates and dyes. In this area imports have in recent years been extremely attrictive substitutes for domestic products, presumably on the basis of price differentials. Thus, monochlorobenzene demand appears sensitive to price factors. The second largest market for monochlorobenzenes is in industrial solvents. This is an area with a large array of potential substitutes, both in economic and technical terms, implying significant demand sensitivity for monochlorobenzene.

o- and p-Dichlorobenzene appear to face similar market conditions. o-Dichlorobenzene has a number of good substitutes in the markets for herbicides and dyes that consume the bulk of its production. p-Dichlorobenzene competes heavily with naphthalene for the moth control market.

The less prominent chlorobenzenes--1,2,4-trichlorobenzene, 1,2,4,5-tetrachlorobenzene, and pentachlorobenzene--appear to face somewhat less competition in their markets. Even here, however, proportions of 1,2,4-trichlorobenzene-based herbicides could, for instance, be cut back in the face of price increases.

IV.A.2.b. Market Expectations

Closely tied to the above observations is the very weak market performance of chlorobenzenes over the past few years, and what must probably be the pessimism with which the industry regards the future. In 1977, for instance, there were ten producers and two processors (using the general industry definition] of dichlorobenzenes across the nation. Today, that number has declined to six producers and two processors. While those firms leaving the market were generally small with older plant facilities, such behavior would be unlikely were there strongly optimistic expectations among chlorobenzenes producers.

Of all the markets surveyed for chlorobenzenes, only that for solvent carriers used in the manufacture of isocyanates appears to be growing. Overall, this market alone does not appear large enough to counteract a continued downtrend in other markets.

IV.A.2.c. Cost Characteristics

The highest volume chlorobenzenes (monochlorobenzene, o- and p-dichlorobenzenes) are produced as complementary products. While the proportions of the products can be varied fairly widely, none can go to zero. That is, if one product is desired, all must be produced, if only in minor quantities. However, the higher chlorobenzenes are produced by further chlorination of para- and ortho-dichlorobenzene in a stepwise manner. This suggests the possibility of cascading effects from testing on the higher chlorobenzenes; that is, at each successive level, the production process combines the testing costs with the higher cost of the input chlorobenzene. Given that all joint products might be separately faced with the expense of testing requirements and the possibility of cascading costs, there is the potential that this could lead to situations associated with significant economic impacts. (see Section II.B.3.)

IV.A.2.d. Industry Structure

As pointed out above, industry structure has changed rapidly over the past few years. Cost structure for the industry appears to be quite homogeneous. There are no unique factor inputs and no unique production processes. Transportation costs are not significant.

Today, a relatively small number of producers, each with relatively large production capacities, populate the industry. Given the declining nature of the market and homogeneity of costs, there is no reason to believe that industry behavior is other than competitive.

IV.A.3. Summary

On the basis of competitiveness, low transportation costs, and production complementarity alone, chlorobenzenes could be regarded as a potentially sensitive chemical product, and thus, a candidate for a Level II economic analysis. In addition, the existence of highly price-sensitive markets and declining demand call for a Level II analysis, so that the potential impact of testing requirements may be quantified.

IV.B. Level II. Evaluation

IV.B.1. Overview

As stated in the discussion of economic impact methodology, the steps involved in conducting Level II analysis build upon the foundation of the Level I analysis. Whereas the Level I objective is to identify cases where a potential for economic impact exists, the Level II analysis attempts to quantify the factors considered to be of greatest importance.

Thus, Level II evaluation does not stand on its own. The information presented at Level I is not repeated here; however, much of it is required for the Level II analysis. In particular, the description of the chlorobenzene production process and the discussion of product uses contained in Level I are necessary for a full understanding of Level II.

Six compounds of the chlorobenzene group are examined here. These are:

- o Monochlorobenzene;
- o Ortho-dichlorobenzene;
- o Para-dichlorobenzene;
- o 1,2,4-Trichlorobenzene;
- o 1,2,4,5-Tetrachlorobenzene;
- o Pentachlorobenzene.

Of these, the first three are the most prominent in terms of physical quantities and economic value. These three are sufficiently described by existing data to analyze in some detail. Data on the last three chlorobenzenes (the "higher level" chlorobenzenes), are very limited.

The following sections adhere closely to the methodology described earlier.

IV.B.2. Demand Analysis

IV.B.2.a. Specification

As was discussed in Section IV.A.2.a. the most important factor in the demand for chlorobenzenes is the availability of substitutes. Demand for a product can, in general, be divided into two distinct categories: final consumption demand and intermediate input demand. The determinants of final demand are derived from utility maximization, whereas, demand for the products as a factor of production is based on profit maximization by the firm.

The demand for a final product derived from utility maximization depends upon:

a) The price of the product (referred to as "own" price);
b) The prices of other products consumed;
c) The consumer's income;

c) Other "shift" factors, such as tastes, income distribution, total population, etc.

For purposes of estimation through multivariate regression analysis (see Appendix for an explanation of this common statistical methodology), the consumer demand function is specified as follows:

$$Q_D = f(P_o, P_s, P_c, Y, Z, u)$$

where

Q_d = Quantity of the product demanded

P_o = The "own" price of the product

P_s = Price vector of substitute products

P_c = Price vector of complementary products

Y = The income of consumers

Z = Exogenous "shock" variables (e.g., dummy variables)

u = Stochastic disturbance term

Demand for factors of productions, on the other hand, is derived from profit maximization or cost minimization. Thus, the major factors which determine the demand for one input are the prices of all inputs, the quantity of the output produced, and the price of the product. The function can be specified as follows:

$$Q_D = f(P_o, P_I, P_p, Q_p, Z, u)$$

where

Q_D = Quantity of the factor demanded

P_o = The "own" price of the factor

P_I = Price vector of other inputs.

P_p = Price of the output product

Q_p = Quantity of the output produced

Z = Exogenous shock factors affecting production

u = Stochastic disturbance term

The estimation of demand for the three major chlorobenzenes will be discussed in the following section.

IV.B.2.b. Estimation

Chlorobenzenes are utilized in a wide range of products. These products include consumer products such as space deodorants, and producer products, such as organic intermediates. Hence demand for chlorobenzenes is a composite of final consumer demand, as well as demand by other manufacturing firms. The demand functions for these two types of purchasers of chlorobenzenes are based on different assumptions regarding their economic behavior. Hence, it is not immediately obvious which form of the demand specification discussed in the previous section is appropriate. In addition to this, economic theory has not developed a model which satisfactorily incorporates both sources of demand for a single product.

Thus, the demand functions to be estimated for the three principal chlorobenzenes will be of a simple nature and will employ commonly used multivariate regression techniques (See Appendix). In general, the demand for the product is estimated as a function of its own price, the price of an important technical substitute and national income, as measured by real (i.e., price deflated) GNP. The purpose of including GNP as an explanatory variable is an attempt to bridge the gap between the two types of demand functions. GNP is used as a measure of income for final demand and as a measure of business activity or output for intermediate demand.

The data used for this study are time-series data compiled from various sources, including trade publications and government documents (see Table IV-6). All prices are expressed in real terms, deflated by the Producers Price Index. The period covered by the data is from 1962 through 1978. The total production and real prices for the three chlorobenzenes considered in this demand analysis (monochlorobenzene, ortho-dichlorobenzene, and para-dichlorobenzene) are plotted in Figures IV-3a, b, and c.

For the purposes of the current analysis, it was felt a simple functional form for the demand equations would yield satisfactory results. Although linear demand equations have been estimated, a log-linear specification provides better fits and facilitates interpretations of the coefficients. The results reported here are from the log-linear specification.

The demand for monochlorobenzene is estimated as a function of its own price, the price of perchloroethylene (a competing solvent in some uses) and real GNP. The estimated equation is:

TABLE IV-6: CHLOROBENZENES PRODUCTION AND PRICES[1]

Year	Mono-chlorobenzene		Ortho-dichlorobenzene		Para-dichlorobenzene	
	Production (Million lbs.)	Real Price[2] (¢ per lb.)	Production	Real Price	Production	Real Price
1962	554.3	7.3840	46.7	10.5485	74.6	10.5485
1963	518.8	7.4074	52.3	10.5820	74.6	10.5820
1964	537.5	6.3358	52.3	11.6156	63.2	9.5037
1965	546.3	6.2112	41.1	11.3872	65.8	9.3168
1966	576.7	6.0120	51.4	10.0200	66.3	9.0180
1967	483.3	6.0000	50.4	10.0000	66.5	9.0000
1968	575.8	5.8537	60.6	10.7317	70.3	9.7561
1969	602.0	5.6338	70.4	9.3897	52.1	8.4507
1970	484.9	5.4348	66.2	9.0580	69.6	8.1522
1971	408.9	4.3898	53.6	8.7796	70.4	7.0237
1972	403.5	5.0378	62.4	10.0756	77.3	7.5567
1973	397.4	5.1967	66.0	9.6511	62.7	6.6815
1974	379.4	13.3666	54.7	10.3061	•	•
1975	306.0	14.2939	54.6	16.0091	48.5	14.2939
1976	329.1	14.2077	48.9	16.9399	36.7	13.1148
1977	325.5	10.2987	47.7	13.9032	65.1	11.8435
1978	295.4	10.5112	41.1	12.4224	41.2	12.9001

---

[1] Sources: Compiled from various publications, including Synthetic Organic Chemicals, U.S.I.T.C., and Chemical Marketing Reporter.

[2] Deflated by the Producer's Price Index, U.S. Department of Commerce.

FIGURE IV-3a; MONOCHLOROBENZENE, QUANTITY PRODUCED (Q) AND REAL PRICE (P)

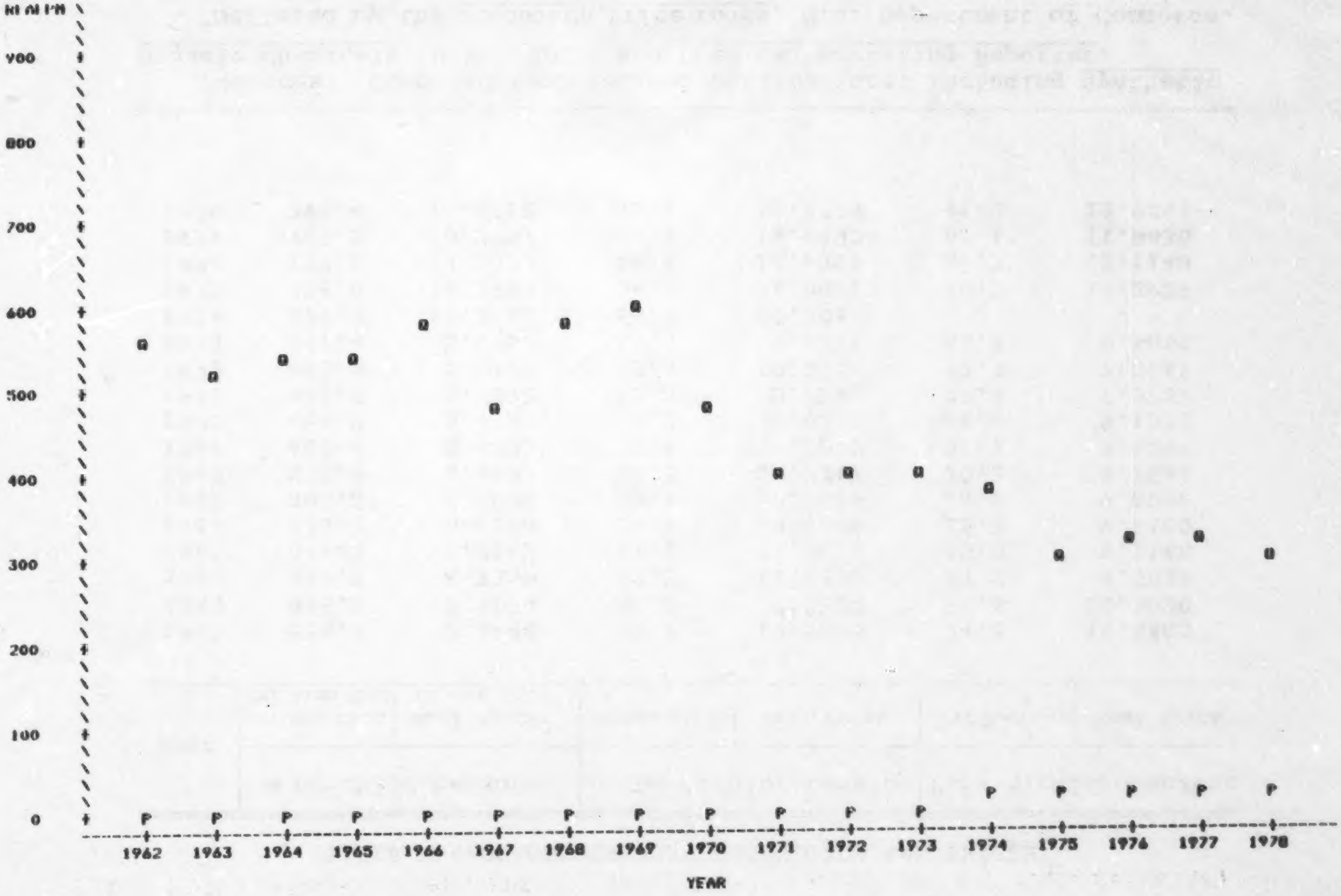


FIGURE IV-3b: ORTHO-DICHLOROBENZENE, QUANTITY PRODUCED (Q) AND REAL PRICE (P)

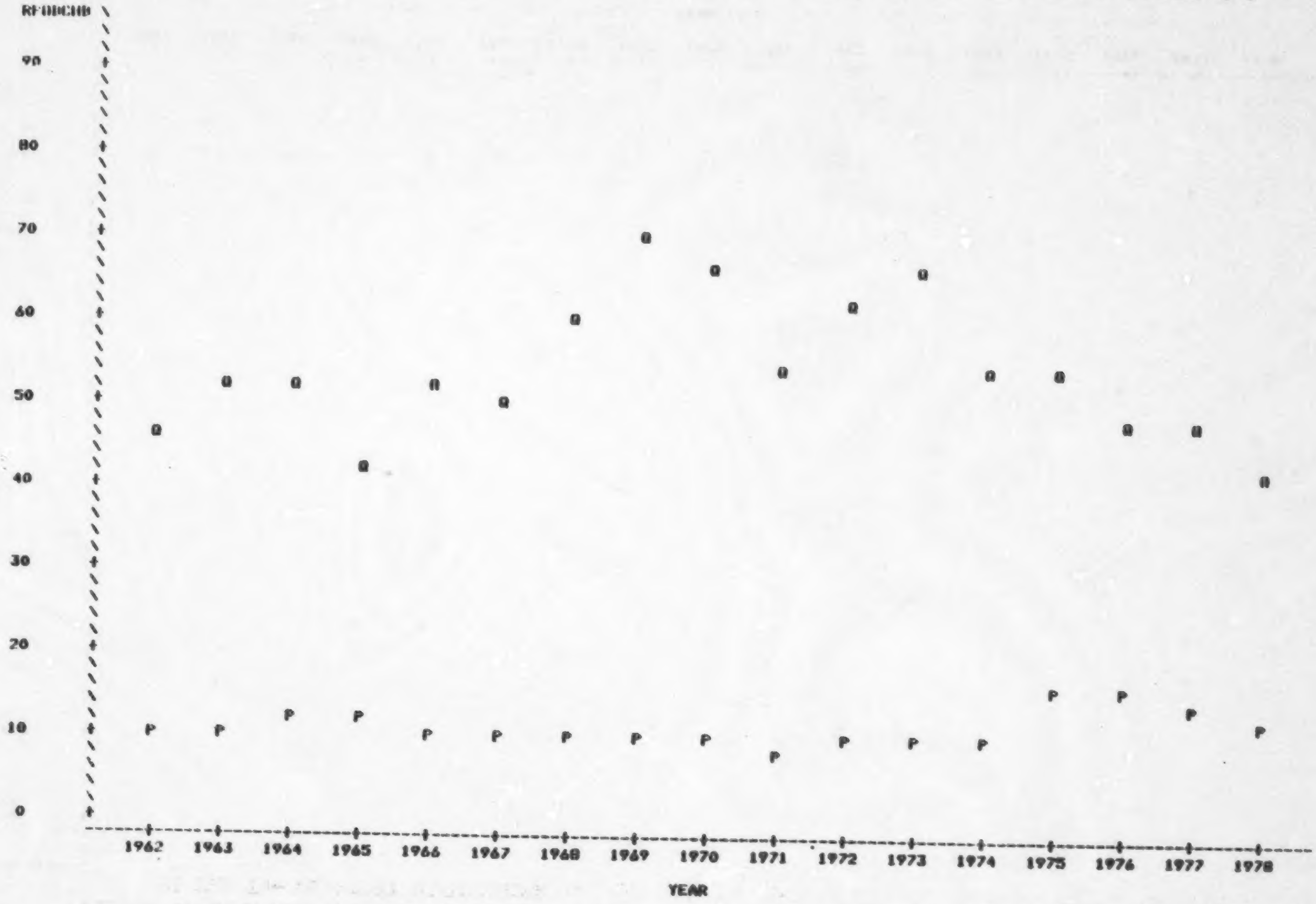
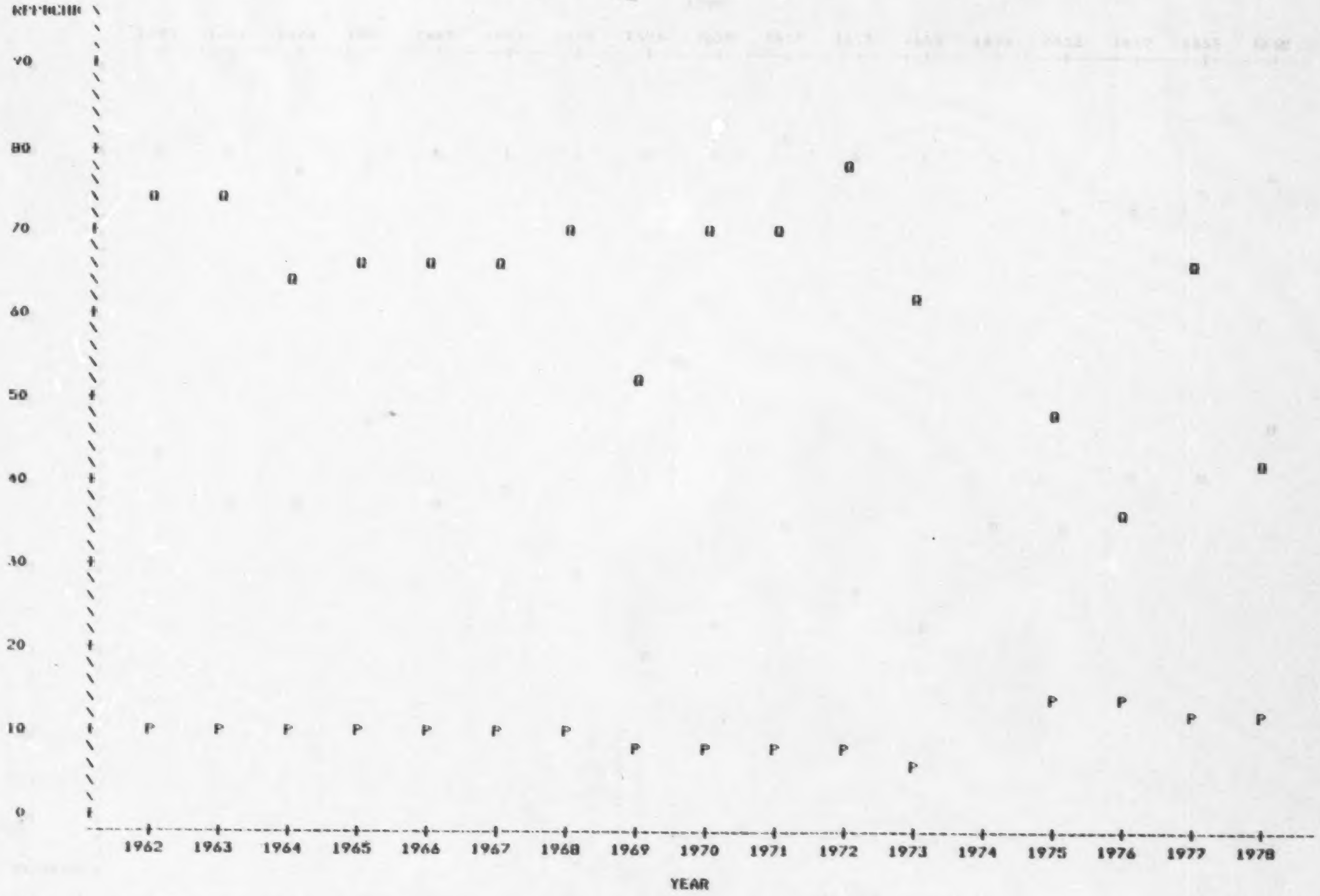


FIGURE IV-3c:PARA-DICHLOROBENZENE, QUANTITY PRODUCED (Q) AND REAL PRICE (P)



NOTE: 2 OBS HAD MISSING VALUES

$$\ell n\ Q_M = 12.52 - .24\ell n\ P_M + .09\ell n\ P_p - .88\ell n\ GNP$$
$$(4.22)^* \quad (-2.73)^* \quad (0.34) \quad (-2.49)^*$$

$$R^2 = .79 \quad F = 16.32 \quad N = 17 \quad D_W = 1.48$$

where

Q_M = Quantity of monochlorobenzene produced

P_M = Average annual selling price of monochlorobenzene

P_p = Average annual price of perchloroethylene

GNP = Real Gross National Product in 1972 dollars

The values in parentheses below each estimated coefficient are the t-statistics, used to test the hypothesis that the value of the coefficient is zero. An asterisk indicates that the coefficient is significant at the 95 percent level of significance ($t_{.95} = \pm 2.160$). The coefficient of determination R^2 indicates that 79 percent of the variation in monochlorobenzene production is explained by the model. The F-statistic indicates that the null hypothesis that all coefficients are equal to zero is rejected. The Durbin-Watson statistic lies between the upper and lower bounds and, hence, the test for autocorrelation is inconclusive. The coefficients on the variables will be interpreted in the next section.

The demand for ortho-dichlorobenzene is estimated to be a function of its own price, that of perchloroethylene, and of real GNP. The estimated equation is:

$$\ell n\ Q_{OD} = 1.83 - .51\ell n\ P_{OD} + .14\ell n\ P_p + .44\ell n\ GNP$$
$$(0.48) \quad (-2.17)^* \quad (0.91) \quad (0.38)$$

$$R^2 = .29 \quad F = 1.79 \quad N = 17 \quad DW = 1.32$$

---

[*] An asterisk after the reported t-statistic indicates significance at the 95 percent level.

Although the coefficient on own price is negative, reflecting a negatively sloped demand curve, the R^2 is low and from the statistic we cannot reject the null hypothesis that the model explains none of the variation in quantity demanded. Again, the Durbin-Watson statistic lies in the nonconclusive range.

The primary uses for p-dichlorobenzene are in the space deodorant and moth control markets. As noted above, the major substitute for p-dichlorobenzene in the moth control market is naphthalene. Thus, the quantity of paradichlorobenzene is estimated as a log-linear function of its own price, the price of naphthalene, and real GNP. The estimated equation is:

$$\begin{array}{lllll} \ell n\, Q_{pD} = & 8.52 & -\ .16\ell n P_{pD} & -\ .28\ell n\, P_N & -\ .51\ell n\, GNP \\ & (4.46)^{*} & (-0.47) & (-1.15) & (-1.97) \\ R^2 = .64 & & F = 6.95 & N = 16 & DW = 2.81 \end{array}$$

In this case as well, the equation implies a negatively sloped demand curve; however, the coefficient on own price is not statistically significant. In fact, none of the variables is found to be significant at the 95 percent level of significance. In spite of this, the overall equation does account for 69 percent of the variation in quantity demanded, and from the F-statistic we reject the hypothesis that all coefficients are equal to zero. A possible explanation for this discrepancy is that significant multicolinearity may exist among the independent variables. This has the effect of increasing the standard error for each coefficient (and, hence, reducing the t-statistics), whereas the overall model may fit the data very well. Once more, the Durbin-Watson statistic lies between the two bounds and no conclusion may be drawn regarding serial correlation. The number of observations for this regression is 16, due to the fact that some data is unavailable for 1974.

IV.B.2.c. Interpretation

The specification of log-linear demand functions allows simple interpretation of the estimated coefficients. This functional form implies a hyperbolic demand curve which exhibits a constant price elasticity of demand along all portions of the curve. The estimate of the elasticity is the same as the estimated coefficient for the own price variable. In addition, the other coefficients can be interpreted as elasticities of demand with respect to the other variables.

The price elasticity of demand measures the proportionate change in quantity demanded due to a small proportionate change in the price of the product ($\epsilon_D = \%\Delta Q / \%\Delta P$).* The basic determinants of the (own) price elasticity of demand are:

a) The availability of substitutes;
b) The nature and number of uses for the product;
c) The time horizon;
d) The proportion of income spent on the product.

For monochlorobenzene, the estimated equation appears to be a reasonable model of demand. The own price coefficient is statistically significant and of the expected sign. The (own) price elasticity of demand is low (-.24), indicating rather inelastic demand. This usually occurs if the product has very specialized uses with few good substitutes. This appears to be borne out by the equation: the cross-price elasticity of demand for the best substitute, perchloroethylene, is low (inelastic) and statistically insignificant. This would imply that either perchloroethylene is not the major substitute, or there is no reasonable substitute for monochlorobenzene. The coefficient on real GNP is negative, indicating that as real GNP has risen, the quantity of monochlorobenzene produced has dropped. This is explained by a shift in technology away from monochlorobenzene in the production of several end products. Ideally, a shift variable would be specified in the equation to account for this trend.

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*Demand is termed inelastic (insensitive to price) when $|\epsilon_D| < 1$, and elastic (sensitive to price) when $|\epsilon_D| > 1$.

With respect to ortho-dichlorobenzene, the equation appears to be a less than satisfactory model for demand. In spite of the fact that a negatively sloped demand curve results, the equation overall fits poorly. No other variable is significant, although the expected signs are obtained. According to the equation, demand is price inelastic (-.51) and the cross-price elasticity with respect to the substitute is also low (0.14). Econometrically the reason for the low explanatory power of the equation is that the independent variables exhibit less variation over time than the dependent variable.

For both monochlorobenzene and o-dichlorobenzene, the coefficient on the price of perchloroethylene variable is not statistically significant at the 90 percent level. The reason for this is the fact that these chlorobenzenes have a wide range of uses with many competing substitutes. Thus, no single product accounts for the major substitution possibilities and results in a statistically significant effect on the chlorobenzenes. In light of comments received from industry on these models, alternative hypotheses were tested for substitute products. These included nitrobenzene and phenol, as well as toluene diisocyanate and xylene. In each case the effects were insignificant and the results less satisfactory. The reason for this may be that perchloroethylene better represents the class of substitutes for these chlorobenzenes (i.e., is more highly correlated with changes in the prices of other actual substitutes) than the alternative substitutes. This is, of course, speculative. Because the data are derived from the same sources, there is no reason to suspect differences in the quality of the data. However, this may well be the case. Unfortunately, there is no way to evaluate this or to incorporate such discrepancies into the model.

For p-dichlorobenzene, demand appears to be price inelastic (-.16); however, as noted above, the coefficient is not statistically significant. Also, all estimates of the coefficients are negative and insignificant. Thus, although naphthalene is a known substitute for p-dichlorobenzene, in the estimated equation it appears as a complement. Again, demand for p-dichlrobenzene appears to be negatively correlated with real GNP.

Since the major objective of this estimation section is to obtain estimates of the price elasticities of demand, the specification of simple demand functions has yielded useful results. The (constant) elasticities of demand for the chlorobenzenes are:

$$\varepsilon_M = -.24$$

$$\varepsilon_{oD} = -.51$$

$$\varepsilon_{pD} = -.16$$

The following section will begin to develop some of the information that will be necessary to interpret these results for the chlorobenzenes industry. Specifically, the relationships estimated to this point have ignored the supply side of the chlorobenzenes markets and this must be included. Integration of supply and demand will take place in Section IV.B.6 Impact Analysis.

IV.B.3. Industry Structure and Competition

IV.B.3.a. Methodology

The objective of this section is to present and interpret information on the production system for chlorobenzenes in order to illuminate further (1) the nature of the industry supply function and (2) the pathways through which regulatory impacts might proceed. Information compiled in this section will help link the outputs of previous sections to subsequent potential impacts or production, employment, profitability, etc.

Several factors are of particular interest with regard to industry supply. First of all, it is important to determine whether there are differences in the average costs of producing chlorobenzenes among the several firms participating in the market. Economic theory suggests that the equilibrium price for chlorobenzenes will be set below the costs of the most efficient firm excluded from the market, but about or equal to the costs of the least efficient producer included. Thus, the greater the diversity of costs among firms, the greater the economic rents earned for the industry and the greater its ability to absorb testing costs without major dislocation. On the other hand, the more uniform are costs, the greater the potential for significant impact since the firms are not able to absorb the additional costs.

While the cost diversity can result from a number of causes, particularly entrepreneurial abilities, this level of analysis focuses primarily upon those factors determined external to the firm itself, namely, raw material inputs and transportation costs. Such factors are relatively easy to observe and to examine for cost advantages.

The following section also examines evidence bearing upon an important related factor: the significance of scale economies.

IV.B.3.b. Change in Industry Structure

Chlorobenzenes have been produced domestically since 1915 when Hooker Electrochemical Company opened a

20 million lb. monochlorobenzene facility at Niagara Falls, New York. Dow Chemical began production later in the same year, and since then for more than 60 years, chlorobenzenes have been a major industrial organic chemical group.

Recently however, the continued commercial viability of this established chemical group has appeared open to question. In particular, the past two years have witnessed a significant decline in the number of chlorobenzene producers. The total number has dropped from ten in 1977 to six in 1979. An additional facility appear to have exited in 1975 or 1976.

Table IV-7 lists information regarding the facilities recently closed. All closed facilities produced the three basic chlorobenzenes--monochlorobenzene, o-dichlorobenzene, and p-dichlorobenzene--but the extent to which the higher order chlorobenzenes were produced is unknown. Capacity is listed in terms of monochlorobenzene production, and this indicates that the decline in capacity was not nearly as significant as the decline in the number of producers. Those producers leaving the industry were extremely small, with none exceeding 20 million lbs. per year capacity. Total monochlorobenzene capacity fell by only five to ten percent, even though the number of producers was nearly halved.

Although the exit of small producers is certainly an indication of the existence of scale economies in the production of chlorobenzenes, it should also be noted, first, that despite reduced monochlorobenzene capacity, the industry

TABLE IV-7: CAPACITIES OF RECENTLY* CLOSED CHLOROBENZENE PLANTS

Manufacturer	Location	Plant Capacity Millions lbs. Per Year
Allied Chemical Corp.	Syracuse NY	20
Dover Chemical Corp. (Subsidiary of ICC Industries, Inc.)	Dover OH	10
Guardian Chemical Corp.	Hauppauge NY	n.a.
Solvent Chemical Co.	Malden MA	3
	Niagara Falls NY	20
Vertac	Jacksonville AR	n.a.

*Closed during mid-to-late 1970s.

capacity utilization rate appears to have fallen significantly,[*] and second, that four of the six closed facilities were located in the northeast, with three of these in New York State. Thus, falling demand and geographical location may have had as much to do with commercial viability as plant scale and costs.

Another factor with possible significant influence is the loss of inexpensive benzene supplies from coke ovens. Problems in the domestic steel industry have lead to a general reduction in coking capacity nationwide, with particularly drastic reductions in some localities. While this factor is not examined in depth here, it may well have been a factor in the closing of the plants in upstate New York and in Ohio.

The following sections examine the individual characteristics of the chlorobenzene plants currently in operation and their regional configuration.

IV.B.3.c. Regional Structure

Chlorobenzene plants are located in the eastern, southern, midwestern, and western areas of the United States (see Figure IV-4). By far the majority of the production capacity is located west of the Alleghenies. These facilities are Dow Chemical at Midland, Michigan; Monsanto at Sauget, Illinois. PPG Industries is located at Natrium, West Virginia. The plants in the west are Montrose Chemical at Henderson,

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[1] Since captive production tends to obscure overall production figures, it is not possible to quote an absolute capacity utilization figure. In relative terms, capacity utilization appears to have dropped by about ten percentage points from 1974 to 1978.

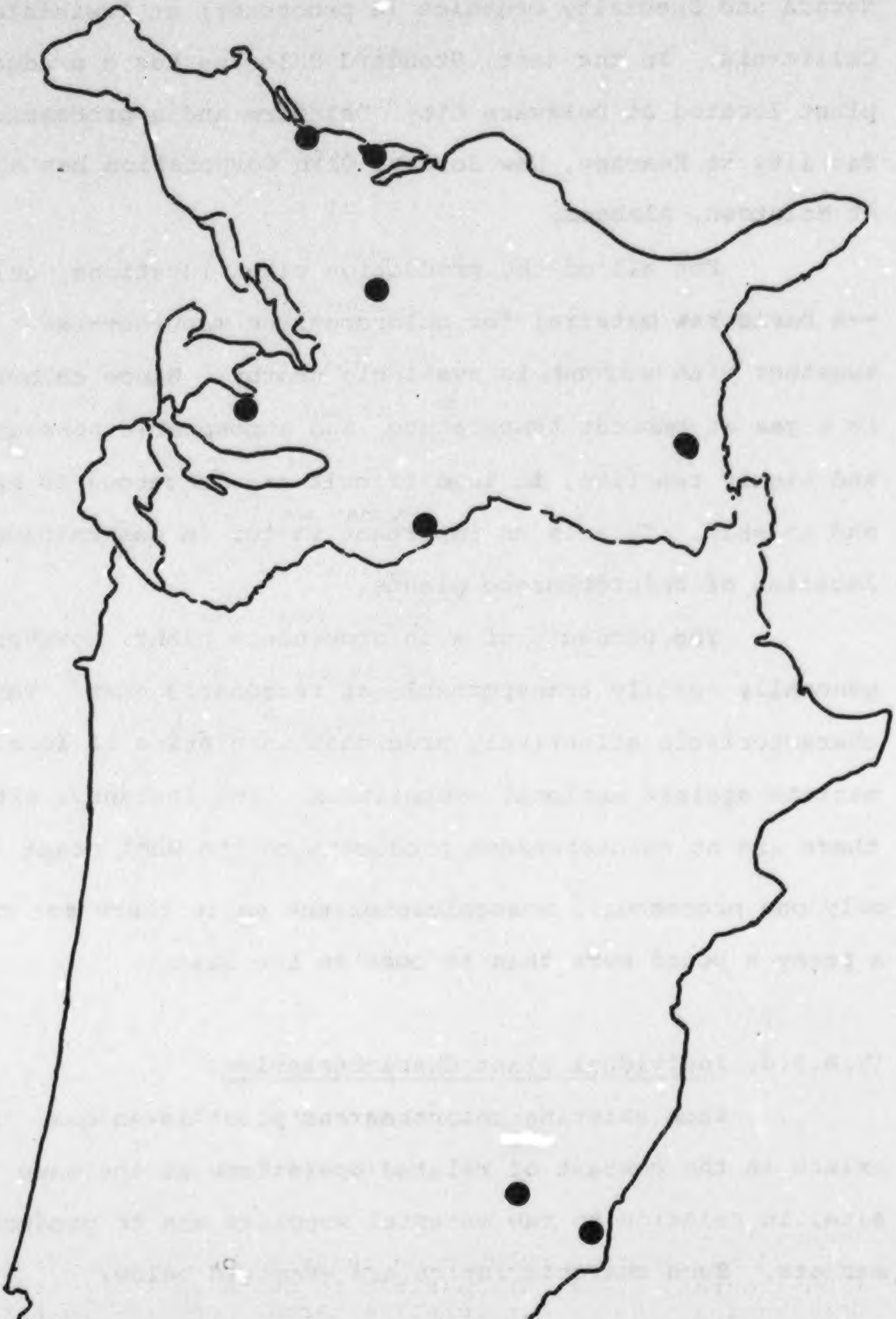

FIGURE IV-4: CHLOROBENZENES PRODUCERS AND PROCESSORS, LOCATIONS

Nevada and Specialty Organics (a processor) at Irwindale, California. In the east, Standard Chlorine has a production plant located at Delaware City, Delaware and a processing facility at Kearney, New Jersey; Olin Corporation has a plant at McIntosh, Alabama.

For all of the production plant locations, chlorine --a basic raw material for chlorobenzene manufacture-- together with benzene, is available nearby. Since chlorine is a gas at ambient temperature and atmospheric pressure and highly reactive, it is difficult and dangerous to handle and to ship. This is an important factor in determining the location of chlorobenzene plants.

The products of a chlorobenzene plant, however, are generally readily transportable at reasonable cost. This characteristic effectively precludes insulation of local markets against national competition. For instance, although there are no chlorobenzene producers on the West Coast (and only one processor)*, monochlorobenzene sells there for only a penny a pound more than it does in the East.

IV.B.3.d. Individual Plant Characteristics

Each existing chlorobenzene plant is unique. Each exists in the context of related operations at the same site, in relation to raw material supplies and to product markets. Such characteristics are examined below.

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*Montrose in Nevada does not market chlorobenzenes.

IV.B.3.d.1. Dow Chemical; Midland, Michigan

Dow Midland has the largest chlorobenzene production capacity in the nation. The annual capacity for monochlorobenzenes is 220 million lbs. and that for o- and p-dichlorobenzenes is 30 million lbs. each. This facility alone accounts for nearly one-third of the total domestic monochlorobenzene capacity. Dow Midland is also a producer of 1,2,4-trichlorobenzene and 1,2,4,5-tetrachlorobenzene. However, the production capacity of these chemicals is not available. The other isomers of tri- and tetrachlorobenzenes are also produced, but only as by-products and are probably disposed of.

Dow's Midland chemical facilities and production center at Midland, Michigan is also Dow Chemical corporate headquarters. Approximately 10,000 persons are employed by Dow in the Midland area. Of this number, between 6,500 and 7,000 are employed at the production plants, and another 3,000 at headquarters offices. The number of employees specifically associated with chlorobenzene production is 60.[20]

Dow Midland produces the chlorine input to the chlorobenzene process on site. There is no specific information regarding the source of its benzene supply; however, Dow Chemical owns the 22,000 bbl/day Bay Oil Refinery in nearby Bay City, Michigan.

The chlorobenzenes produced at Midland are used both as chemical intermediates on site and as marketable products. Those used internally are made into various pesticides, herbicides, flocculants, cosmetics, and medicinals. It can be surmised that a large portion of those chlorobenzenes produced at Midland and sold externally are purchased by Dow Corning's adjacent plant as input to its silicone manufacture.

IV.B.3.d.2. Monsanto Chemical; Sauget, Illinois

Monsanto Chemical maintains a facility of 150 million lbs. annual monochlorobenzene capacity at its Sauget, Illinois plant near East St. Louis, Illinois. The chemicals produced at this plant include phosphorous compounds, chlorinated amines, hydrochloric acid, chlorine-caustic soda, sulphur compounds, and phenols.[3] Approximately 1,250 persons are employed at this location.

The Sauget plant produces its own chlorine and has ready access to petrochemicals including benzene from the oil refineries concentrated at Wood River, Illinois, a few miles north of East St. Louis.

All the monochlorobenzene produced at Sauget is used internally, probably in the synthesis of amine compounds. p-Dichlorobenzene production reportedly is committed in its entirety ot three large industrial customers, while o-dichlorobenzene is sold on a spot basis.

IV.B.3.d.3. Montrose Chemical; Henderson, Nevada

Montrose Chemical (owned jointly by Chris Craft and Stauffer Chemical Co.,) produces chlorobenzene at Henderson, Nevada. Although statistics are almost nonexistent, this company uses its total chlorobenzenes production captively for the manufacture of DDT, a pesticide.[22] As noted earlier, DDT domestic use has been severely restricted by Federal regulation in recent years. It is believed that today Montrose Chemical is the only producer of this substance in the United States, and that almost all is exported.

Other chemicals produced by Montrose Chemical at this location are chloral and hydrochloric acid. The total operation requires 112 employees. Chlorine is probably purchased from a nearby Stauffer plant. The source of benzene is not known. It is believed that the Henderson plant is the only location of the Montrose Chemical Corporation.

IV.B.3.d.4. Olin Corporation; McIntosh, Alabama

Olin Corporation produces pentachlorobenzene as an in-the-pipe intermediate for the manufacture of pentachloronitrobenzene (PCNB) at its plant at McIntosh, Alabama. Fungicidal formulations of Terrazole® are also prepared here.[3] Olin Corporation produces chlorine and sodium hydroxide on this site. Therefore, a ready supply of chlorine is available for the chlorination of tetrachlorobenzene to pentachlorobenzene.[20]

Although Olin Corporation produces a wide range of halogenated benzenes and toluenes, cyclic amines, and isocyanates at a number of locations, none of these chemicals are produced at McIntosh.[3]

IV.B.3.d.5. PPG Industries; Natrium, West Virginia

PPG Industries produces chlorinated benzenes at its Natrium, West Virginia plant. Monochlorobenzene, o- and p-dichlorobenzenes, and 1,2,4-trichlorobenzene and mixed 1,2,3- and 1,2,4-trichlorobenzenes are all manufactured here. Other chemicals produced at this site are sulfur compounds, sodium hydroxide, hydrogen, and ammonia. Approximately 818 people are employed by PPG at the Natrium plants.

PPG Industries produces chlorine at this location and thus, has it readily available for use in production of chlorobenzenes. The source of benzenes is not known, but might be at least partially drawn from the byproduct discharges of nearby coke ovens. It is believed that a large portion of PPG's monochlorobenzene production at Natrium is claimed by the adjacent Mobay Chemical Co. plant for use as a solvent in the manufacture of isocyanates.

IV.B.3.d.6. Standard Chlorine Chemical; Delaware City, Delaware and Kearny, New Jersey

Standard Chlorine, the only producer of chlorobenzenes on the East Coast, has two facilities. The first is located at Delaware City, Delaware and produces a full range of chlorinated benzenes, while the second is in Kearny, New Jersey and processes only o- and p-dichlorobenzene mixtures.[3]

The company has 150 million lbs. production capacity for monochlorobenzene at Delaware City, Delaware, while the combined total capacity for o-dichlorobenzene for both locations is 66 million lbs., and for p-dichlorobenzene is 90 million lbs. Each of the plants employs fewer than 100 persons.

As might be expected from the chemistry of the manufacture of chlorobenzenes, hydrochloric acid is also produced at Standard Chlorine's Delaware City plant. No other chemicals are produced at either site.[3] A subsidiary of Standard Chlorine, Chloroben, Inc., operates a manufacturing facility adjacent to the Kearny processing plant that produces waste and septic system chemicals and it is believed that much of the p-dichlorobenzene production is used there. As the nation's largest producer of o- and p-dichlorobenzenes, Standard Chlorine is also thought to be a major exporter of these chemicals.

IV.B.3.d.7. Specialty Organics; Irwindale, California

Specialty Organics of Irwindale, California, is one of two processors (in terms of conventional industry definition) of o- and p- dichlorobenzenes in the nation, and is the only producer or processor of o- and p-dichlorobenzenes on the West Coast. Processors separate mixtures of o- and p-dichlorobenzenes into their individual components. The Irwindale processing capacity for o- and p-dichlorobenzene is 2 million lbs. each. In comparison, Dow, PPG, and Standard Chlorine have dichlorobenzene capacities of 30, 20, and 66 million lbs., respectively; and p-dichlorobenzene capacities of 30, 30 and 90 million lbs.

Processing of dichlorobenzenes accounts for approximately 80 percent of Specialty Organics' business which is approximately a million dollars a year. The Company employs ten persons The source of its materials is not known.

Table VI-8 summarizes the information on chlorobenzene producers presented above.

IV.B.3.e. Interpretation

Several observations may be drawn from the discussion above.

- There appear to be economies of scale in the production of chlorobenzene but the relative importance of scale is not clear.
- Transportation costs in the acquisition of chlorine are potentially important. But, since all existing producers have onsite sources of chlorine, this is not a competitive factor.
- Transportation costs for chlorobenzene products are not a factor. Local markets can be insulated only to a very small extent.
- No existing producer appears to have an assured low-cost source of benzene. Sources appear plentiful and competitively priced.
- The upperbound for the number of employees necessary to support a large chlorobenzene production facility appears to be 100, as based upon the Standard Chlorine Chemical Delaware City plant, and as confirmed by the Montrose Chemical plant. The employees incremental to chlorobenzene production, particularly in larger, integrated chemical refineries, are probably considerably fewer.

TABLE IV-8: CHLOROBENZENES PRODUCERS, 1979

Company	Location	Employees	Monochlorobenzene Capacity (Million lbs.)	Products
Dow Chemical	Midland, MI	6,500-7,000	220	Manufactures more than 150 chemical products, including halogenated organics, pesticides, methylcellulose, flocculants, cosmetics, heat transfer agents, medicinals, etc.
Monsanto Chemical Intermediates	Sauget, IL	1,250	150	Manufactures industrial organic chemicals, including phosphorous compounds, chlorinated benzenes, chlorinated amines, hydrochloric acid, chlorine-caustic soda, sulfur compounds, phenols.
Montrose Chemical	Henderson, NV	112	70	Manufactures chloral, chlorinated benzenes, hydrochloric acid, DDT.
Olin Corporation	McIntosh, AL	100	0	Manufactures pentachloronitrobenzene and PCNB.
PPG Ind.	Natrium, WV	818	90	Chlorine-caustic soda, sulfur compounds, chlorinated benzenes, hydrogen, ammonia.
Specialty Organics	Irwindale, CA	10	0	Processor of chlorinated benzenes.
Standard Chlorine Co., Inc.	Delaware City, DE	51-100	150	Chlorinated benzenes, hydrochloric acid.
	Kearny, NJ	100	0	Processor of chlorinated benzenes.
TOTAL			>680	

SOURCES: References 1,2,4,11,22,23,25,26,31,33,35, Thus, given these conclusions in conjunction with a common, relatively uncomplicated production process, it is probable that the cost distribution for chlorobenzene production is quite uniform across producers. This implies a rather flat (elastic) industry supply curve.

While an elastic supply function would ordinarily imply a potential for significant impact, this situation is mitigated by other structural factors. The recent closing of a number of small, marginal producers has left the chlorobenzene industry with a smaller number of relatively large producers with highly devloped product supply arrangements. Generally speaking, only a very large demand shift would threaten the least efficient producer of those left in the industry. However, in this case one processer may be vulnerable to a decrease in demand.

IV.B.4. Market Expectations

The Level I analysis documented and emphasized the stagnant demand outlook for chlorobenzenes. Little has occurred in this phase of the analysis to indicate any revision of this view.

It does, however, appear that changes are taking place in the international trade of chlorobenzene that, while rather limited in current impact, could affect the long term outlook. Tables IV-9 and IV-10 set forth the intercountry trade flows with the United States during recent years. While the data does not allow examination of specific compounds, the Tables show a very large increase in chlorobenzene

TABLE IV-9 : UNITED STATES IMPORTS BY COUNTRY OF ORIGIN

Mono-, Di-, and Tri-chlorobenzene (MM lbs.)

From	1977	1978	1979 (9 mo.)
Canada	.68	.028	---
Japan	.009	---	.01
United Kingdom	---	.044	.06
Netherlands	.04	1.025	.04
Belgium	---	1.004	---
France	.08	1.031	5.4
Germany	.017	.01	.04
Poland	---	1.02	---
Italy	.12	.08	---
Other	.094	---	.02
TOTAL	1.04	4.242	5.57

TABLE IV-10: U.S. EXPORTS BY COUNTRY OF DESTINATION

o- and p-Dichlorobenzene (MM lbs.)

To	1977	1978	1979 (9 mo.)
Canada	1.4	3.5	8.7
Mexico	2.8	2.5	3.5
Costa Rica	—	.22	.26
Other, Central America	—	.027	.001
Brazil	—	.96	.70
Venezuela	—	.28	—
Other, South America	—	.01	.183
United Kingdom	—	.12	—
Other, Europe	—	.038	—
Israel	—	.308	—
Other, Middle East	—	.007	.005
Japan	3.0	11.714	10.9
Hong Kong	—	.132	.044
Taiwan	—	.158	.196
Other, Asia	—	.049	.04
Rest of World	.5	—	—
TOTAL	7.7	20.023	24.529

trade flows over the past three years. Based on the nine-month annual rate for 1979, imports have increased sevenfold in two years; while exports, starting from a much larger base, have grown by nearly a factor of five.

The export figures are even more startling when it is recognized that the figures do not include monochlorobenzene or the higher level chlorobenzenes. Based on a gross estimate of 1979 combined domestic production of o- and p-dichlorobenzene, it can be seen that domestic consumption is dropped dramatically while exports are becoming a dominant market factor.

Year	Total Production (MM lbs.)	Exports (MM lbs.)	Domestic Consumption (MM lbs.)	Exports as Percent of Production
1977	112.8	7.2	105.6	6.4 %
1979 (est.)	80.0	32.7	47.3	41.0 %

Today, exports to a single country, Japan, are equivalent to a quarter of the total domestic consumption.

While there is little hard information on the causes of such a dramatic change, it is possible to speculate. Benzenoid dyes, once a major item of domestic manufacture, are now imported into the United States in large quantity. It is possible that domestic health and safety regulations on workplace exposure to benzene have had a role in the transfer of this industry overseas. In addition, rapidly growing textile production in Asian countries such as Taiwan and Korea may have lead the Japanese to expand their benzenoid dye capabilities. Japan has neither the cheap energy to manufacture chlorine nor the aromatic petroleum feedstocks to produce significant quantities of benzene, and thus, must import chlorobenzenes.

Another factor may be domestic regulation of pesticides. As a growing number of pesticides have been banned from use in the United States, production capabilities that formerly produced large volumes for export may have been transferred to other countries. Thus, instead of exporting the finished product, the United States might instead be exporting feedstocks.

Overall, while domestic market prospects for o- and p-dichlorobenzenes and their products are not bright, prospects for foreign markets appear to be somewhat brighter.

On the import side, figures are given for chlorobenzenes as a group and some data is available by compound. However, it is interesting to note that while o- and p-dichlorobenzene are exported in trivial amounts to Europe, certain European countries (particularly France) have become important exporters of chlorobenzenes, particularly the tetrachlorobenzenes.

It is not clear, however, why imports of these substances should be increasing when domestic monochlorobenzene capacity utilization is generally felt to be low. One theory is that these imports are displacing the production capacity lost in the Northeast during the past several years. Whatever the reason, it is clear that foreign imports of chlorobenzenes are competitive with domestic products.

IV.B.5. Alternative Approaches

Under the proposed test rule, EPA has advanced three possible regulatory approaches. These were formulated with regard to considerations of sampling within the chlorobenzenes group. Where a decision to sample within a group is made, it also must be decided whether the chemicals selected should be formally treated as individual chemicals or whether the group should continue to be treated as a category for purposes of allocating testing costs. EPA is proposing one approach and considering two alternative approaches for exemptions and reimbursement. Any of the three approaches described below might be adopted in the final rule.

IV.B.5.a. Proposed Approach

This approach envisions a rule requiring testing only of a representative sample of chemicals, sufficient to characterize the category. Manufacturers and processors of all chlorobenzenes, however, would be required to share the costs of testing the sample compounds. EPA specifies its choice of a representative sample as shown in Table IV-11 .

TABLE IV-11

Representative Chlorobenzenes	Other Chlorobenzenes
Monochlorobenzene	Meta-dichlorobenzene
Ortho-dichlorobenzene	1,2,3-Trichlorobenzene
Para-dichlorobenzene	1,3,5-Trichlorobenzene
1,2,4-Trichlorobenzene	1,2,3,4-Tetrachlorobenzene
1,2,4,5-Tetrachlorobenzene	1,2,3,5-Tetrachlorobenzene
Pentachlorobenzene	

While the testing regulations do not prescribe the manner in which testing costs are shared among producers, it is necessary for the purpose of impact analysis to assume a cost distribution scheme. The first component of a distribution scheme is to establish the appropriate cost pool. Generally speaking, this can be done in one of two ways: pool costs by compound, or pool costs by compound groups. In the case of the proposed approach, costs are assumed to be distributed on a group basis; i.e., some producers share in the testing costs for compounds they do not produce.

Secondly, after the cost pool is established, a scheme must be adopted to distribute the pooled costs. This is most easily done on the basis of production volume, although it could conceivably be done on the basis of production capacity, or even on a uniform producer-by-producer basis. Since production volume seems to be a likely measure, it is assumed to prevail in each of the options examined.

The direct costs of testing the representative sample are shown in Table IV-12 below. The procedure for annualizing these

TABLE IV-12 : SUMMARY OF ESTIMATED TEST COSTS FOR CHLOROBENZENES ($ thousands)

Compound	Oncogenic Effects	Teratogenic Effects	Reproductive Effects	Subchronic Effects	Total by Compound (Alternatives 1&2)
Monochlorobenzene	---	$ 50-100	$110- 220	$ 32- 96	$ 192- 416
o-Dichlorobenzene	---	50-100	110- 220	32- 96	192- 416
p-Dichlorobenzene	---	50-100	110- 220	32- 96	192- 416
1,2,4-Trichlorobenzene	$ 328- 983	27- 81	---	28- 84	383-1,148
1,2,4,5-Tetrachlorobenzene	328- 983	27- 81	57- 171	28- 84	440-1,319
Pentachlorobenzene	328- 983	---	57- 171	28- 84	413-1,238
SUBTOTAL (Proposed Approach)	$ 984-2,949	$204-462	$444-1,002	$180-540	$1,812-4,953
m-Dichlorobenzene	$ 650-1,200	$ 50-100	$110- 220	$ 32- 96	$ 842-1,616
1,2,3-Trichlorobenzene	328- 983	27- 81	57- 171	28- 84	440-1,319
1,3,5-Trichlorobenzene	328- 983	27- 81	57- 171	28- 84	440-1,319
1,2,3,4-Tetrachlorobenzene	328- 983	27- 81	57- 171	28- 84	440-1,319
1,2,3,5-Tetrachlorobenzene	328- 983	27- 81	57- 171	28- 84	440-1,319
SUBTOTAL	$1,962-5,132	$158-424	$338- 904	$144-432	$2,602-6,892
GRAND TOTAL	$2,946-8,081	$362-886	$782-1,906	$324-972	$4,414-11,845

SOURCE: Cost Analysis Methodology and Protocol Estimates, TSCA Health Standards and FIFRA Guidelines. Draft Report, Submitted to U.S. Environmental Protection Agency, Office of Regulatory Analysis, by Enviro Control, Inc., April 3, 1980. Adjusted to correspond to proposed test rule.

costs is described in Section IV.B.6. following. The total for the six compounds--$1,812,000 to $4,953,000--represents the overall cost pool to be divided among the producers of the eleven chlorobenzenes.

IV.B.5.b. Alternative I

This alternative is the most difficult to characterize in terms of cost. It requires that all chemicals in the chlorobenzenes category be tested in stages, with the designated representative sample comprising the initial testing stage. If this stage were adequate to characterize the entire category, manufacturers and/or processors of the untested chemicals would obtain an exemption and reimburse the manufacturers and processors who sponsored the first-stage tests.

If the first stage were found to be inadequate to characterize the entire group of chlorobenzenes, the second stage of testing would be required. Producers would be responsible for a share of the test costs for only those compounds they produce.

The principal difficulty with analysis of such an approach is that it involves assigning a probability to the second stage of testing, and such a probability would be almost entirely speculative. To circumvent this difficulty, it is assumed here that the probability is one; that is, second stage testing is a certainty. Such an assumption willobviously bias the cost and impact calculations upward, consistent with the "worst case" methodology explained in a later section.

For purposes of analysis, the grand total of $4,414,000-$11,845,000 from Table IV-12 will represent the testing cost pool applicable to Alternative I.

IV.B.5.c. Alternative II

Although chlorobenzenes would be analyzed as a group for purposes of a Section 4 finding, six chemicals would be selected from the category and tested as individual chemicals. Exemption and reimbursement considerations would be the same as for single chemicals, with only the manufacturers and/or processors of the selected chemicals subject to testing requirements; i.e., no producer would pay for tests of chemicals he did not produce (or process).

Under this alternative, there would be the equivalent of six separate cost pools established--one for each chemical in the representative sample. These costs would be distributed in an equitable manner, assumed for purposes of analysis to be based on production volume.

IV.B.6. Impact Analysis

In this section, the results of previous steps are brought together in order to determine the economic impact of the testing regulations. It is assumed that the costs of the tests will be distributed among the firms according to a reimbursement scheme yet to be devised. As discussed in Chapter

II, it is assumed that each producing firm pays a share of the test costs for chlorobenzenes, based on its proportion of total production:

$$C_j = \beta_j \, TC \; ; \qquad j = \text{firm}$$

where

$\beta_j = P_j/TP$ Proportion of all chlorobenzenes produced by the j^{th} firm

$P_j = \sum_i P_{ij}$ where i refers to the chlorobenzene chemical

$TP = \sum_j P_j$

$TC = \sum_i C_i$.

In the case of Alternative II, each producing firm pays a share of the test costs for those chlorobenzenes it produces, based on its proportion of total production of each individual chemical.

$C_{ij} = \alpha_{ij} T_i$ where i refers to the chlorobenzene
j refers to the firm

The total cost imposed by testing a chlorobenzene is the sum of the costs to those firms producing it:

$$C_i = \sum_j C_{ij}$$

where

C_i = Total cost imposed by testing the i^{th} chlorobenzene

The total costs of testing the chlorobenzenes is the sum of the individual costs:

$$TC = \sum_i C_i$$

It should again be noted that this analysis treats testing costs as though they are incurred in a single year. The "single year" assumption reflects the philosophy of conservatism (i.e., the "worst case" approach) in estimating economic impacts, since the costs may, in fact, be incurred over a two-to-three year period.

IV.B.6.a. Methodology

As discussed in Section II.C.2., the testing costs represent a lump sum or fixed cost to the producers in the chlorobenzene industry. That is, the total cost of testing is not affected by total chlorobenzene production and, hence, the short-run decisions of the firm are unaffected. In the long run, however, firms view all costs as variable. Thus, prior to payment of the costs, firms must determine whether the expected stream of revenues, minus all costs, will yield a positive net present value (NPV). Those firms projecting negative NPV will, if rational, decide to leave the industry. Thus, testing costs may have an impact on the long-run decisions of the firm. This will, in turn, affect the quantity produced and price of the chemical.

In general, an external or exogenous lump sum disturbance is likely to produce the following impacts on a market:

- Aside from the perfectly inelastic demand case, output will fall as the industry supply curve shifts to the left in response to higher costs;
- The price paid by the consumer or buyer is likely to increase, while the seller or producer will realize a lower net return;
- As output falls, industry employment will decrease unless increased production of other chemicals absorbs excess labor.

In order to evaluate the impacts on these factors, a "worst case" methodology has been developed. This will be discussed following the treatment of the direct costs of testing.

IV.B.6.a.1. Annualized Direct Costs of Testing

The annual industry cost of testing depends upon critical expectations concerning the chlorobenzene market in the future. The economically correct procedure here is to discount the cost of testing over the expected life of different chlorobenzenes. As has already been indicated, the market has declined substantially over the past several years. Projecting the future economic life of each chemical is extremely uncertain and has not been attempted here. For this reason, it is important that assumptions made regarding the time horizon and the rate at which future revenues are discounted be biased on the conservative side.

For the purposes of this study, it is assumed that the testing costs are capitalized at the before-tax rate of 20 percent. The time horizon used in this study is 20 years. (capital recovery factor=.20536).[17] These are important assumptions and are subjected to sensitivity analysis in a subsequent section.

In addition to these assumptions, an upper bound to the costs of testing has been derived in order to account for nonlaboratory administrative costs and for the possibility that additional in-depth testing is required. In the absence of hard data on the probabilities that these tests will be required, as well as on the actual cost of these tests, it was decided to increase the high estimate of the direct testing costs by a factor of two. Thus, for the proposed approach and the two alternatives, estimates for the annualized, industry-wide costs of testing are derived as shown in Table IV-13. The low and medium estimates are derived form the range of test costs presented in Table IV-12 for the different alternatives. The high annualized cost estimate is derived as discussed above.

TABLE IV-13: OVERALL ANNUALIZED TEST COSTS ($ thousands)

	Proposed Approach	Alternative I	Alternative II
High Range	$2,034	$4,865	$2,034
Medium Range	1,017	2,432	1,017
Low Range	372	906	372

SOURCE: Table IV-13

These costs are utilized in the "worst case" scenarios in the following sections.

IV.B.6.a.2. "Worst Case" Scenario

The "worst case," that is, the situation in which the market will be most sensitive to economic disturbances is the long-run, competitive equilibrium case. This market scenario has the following characteristics:

- All firms have identical costs;
- Each firm produces at a point where price equals per-unit costs, thus eliminating any economic profit or rent;
- Within the range of relevant output, the industry supply curve is horizontal, or perfectly elastic; that is, no firm will operate if price falls below the current level.

While it is unlikely that the chlorobenzenes industry conforms exactly to these characteristics, from the discussion in Section IV.B.4. we cannot rule out the possibility that the firms in this industry behave in a similar manner. In addition, we consider the worst case scenario for the following reasons:

- It will provide an upper-bound estimate of the potential economic disturbances attributable to TSCA testing requirements;
- It requires only the specification of a demand function, that is, estimates of impacts are feasible even if econometric estimates of the supply curve fail;

Some *a priori* statements concerning the economic impacts can be made in this situation:

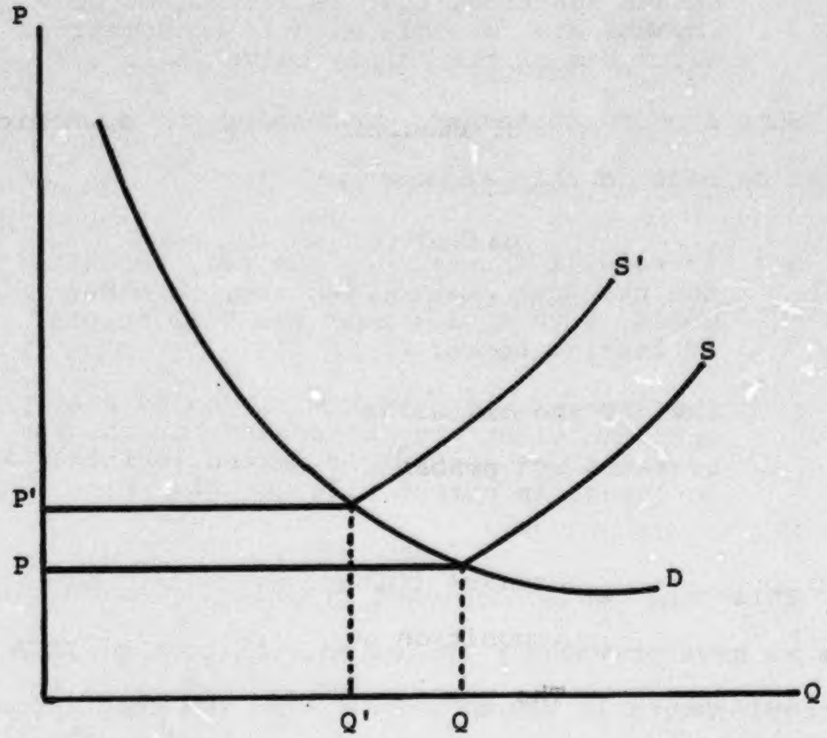
- Price will increase by the full amount of the per-unit cost of testing; in other words, buyers will bear the full burden of testing costs;
- The decrease in output will depend solely upon the elasticity of demand for chlorobenzenes (of course, if demand is inelastic, no change in output will occur).

This case can be depicted graphically as in Figure IV-5. As we have previously indicated, the cost of TSCA testing requirements is essentially a lump sum cost imposed on the industry which will be viewed as a long-run variable cost by firms participating in the industry. However, in order to determine its impact on the industry supply curve, this lump sum fee must be converted to a per-unit cost. Let the annualized industry cost of testing be, a. The per-unit cost, t, can then be expressed as

$$t = a/Q$$

In general, the per-unit burden of testing depends on the industry output; that is, the per-unit cost (or supply curve shift) will be simultaneously determined by the impact of the cost on output. However, in the worst case situation,

FIGURE IV-5: EXAMPLE OF SHIFT IN SUPPLY CURVE DUE TO TESTING COSTS



the supply curve shifts so that the entire amount of the per-unit cost is passed on to the consumer.

IV.B.6.a.3. Results

The differential impacts of each alternative are compared through examination of resultant product price changes. These price changes are calculated on a "worst case" basis; i.e., all costs are fully passed through to prices, no "evasive" actions by producers are possible, testing costs are at the high end of the feasible range and production volumes are at the low end of the minimal range. Such assumptions result in per-unit impacts probably much greater than can be expected in the real world.

Simulated price increases (full pass-through of per-unit test costs) due to the imposition of testing requriements are shown in Table IV-14. The proposed approach results in constant, across-the-board increases, small in relation to sales price. In this case, total testing costs are lumped together and divided by the overall production volume of the representative chlorobenzenes.

The by-product chlorobenzenes are those that are produced in low volume and primarily as by-products. Most are sold in mixture along with the principal products, some are disposed of in reactor tars, and in at least one case, the by-product is purposely separated from the principal product and dealt with as waste.[21]

TABLE IV-14: PER-UNIT ANNUALIZED TEST COSTS, CHLOROBENZENES

PRIMARY PRODUCT	By-Product	Total Production Primary Product[1] (million lbs., 1978)	Sales Price Primary Product[2] (¢/lb., 1978)	ALTERNATIVE I		ALTERNATIVE II		PROPOSED APPROACH
				Total Direct Test Costs[3] (Primary & By-Product) ($ x 1000)	Per-Unit[4] Annualized Cost (¢/lb.)	Total Direct Test Costs[3] (Primary only) ($ x 1000)	Per-Unit[4] Annualized Cost (¢/lb.)	Per-Unit[4] Annualized Cost (¢/lb.)
Monochlorobenzene	---	296.3	26¢	$192-416	.06¢	$192-416	.06¢	.27¢
Ortho-dichlorobenzene	Meta-dichlorobenzene	41.1	26	613-1224[5]	1.2	192-416	.4	.27
Para-dichlorobenzene	Meta-dichlorobenzene	41.3	27	613-1224[5]	1.2	192-416	.4	.27
1,2,4-Trichlorobenzene	a) 1,2,3-Trichlorobenzene b) 1,3,5-Trichlorobenzene	17.1	36	1263-3786	9.1	383-1148	2.8	.27
1,2,4,5-Tetrachlorobenzene	a) 1,2,3,4-Tetrachlorobenzene b) 1,2,3,5-Tetrachlorobenzene	6.4	n.a.	1320-3957	25.4	440-1319	8.5	.27
Pentachlorobenzene	---	6.7	n.a.	413-1238	7.6	413-1238	7.6	.27
TOTAL		740.3		$4414-11845		$1812-4953		

[1] Total production = domestic production plus imports. See Tables IV-2 and IV-4.

[2] See Table IV-2.

[3] See Table IV-12.

[4] From Table IV-13; upper figures from cost distribution multiplied by two for High Range Estimate and annualized. Divided by production on individual chemcial basis for Alternatives I and II. Total production equals divisor for Proposed Approach.

[5] Test cost for m-dichlorobenzene apportioned on a 50 percent basis to both o- and p-dichlorobenzene.

Application of testing requirements to these compounds will have the effect of increasing the costs of their associated principal products, even when the by-product is not present in the commercial mixture. Thus, a figure representing testing costs per-pound for these secondary chlorobenzenes is not relevant, since they are almost never sold as such. (The sole possible exception is meta-dichlorobenzene, which is imported in small amounts as a separate compound.)

Alternatives I and II produce price increases specific to the particular primary chemicals, including allocated by-product testing costs when appropriate. These price increments vary widely from .06¢/lb. on monochlorobenzene to 25.4¢/lb. for 1,2,4,5-tetrachlorobenzene under Alternative I. It can be seen that the very high volume of monochlorobenzene relative to the other chlorobenzenes (40 percent) greatly effects the distribution of test costs among products from one alternative to the other.

It is now possible to combine the results of the demand analysis in order to determine consumption decrements due to the price increases for the lower chlorobenzenes. For monochlorobenzene the increase in price ranges from .27¢/lb. (proposed approach) to .06¢/lb. (Alternatives I & II). Applying the statistically derived elasticity factor (.24), quantity is estimated to fall by amounts ranging between 902,000 and 193,000 lbs. per year--decreases of .31 and .07 percent, respectively. (See Table IV-15.) Due to the large quantity of monochlorobenzene produced annually and the relatively large

TABLE IV-15: PRICE AND CONSUMPTION IMPACTS OF TESTING COSTS FOR THREE REGULATORY ALTERNATIVES

	Increase in Price (cents)	Percent of 1978 Price[1]	Decrease in Consumption (000 lbs)	Percent of 1978 Consumption
Monochlorobenzene				
Proposed Approach	.27¢	1.27%	902.3	.31%
Alternative I	.06	0.27	193.4	.07
Alternative II	.06	0.27	193.4	.07
Ortho-dichlorobenzene				
Proposed Approach	.27	1.04	217.4	.53
Alternative I	1.20	4.44	931.6	2.25
Alternative II	.40	1.48	310.5	.75
Para-dichlorobenzene				
Proposed Approach	.27	1.04	68.4	.17
Alternative I	1.20	4.44	293.0	.71
Alternative II	.40	1.48	97.7	.24

---

[1] Using 1978 actual (not deflated) sales prices.

size of the plants producing it, this would appear to constitute a minor impact on the monochlorobenzene producers.

With respect to o-dichlorobenzene, the burden of the additional costs is distributed over a smaller quantity of production and, hence, the increase in price is greater--ranging from .27 to 1.2 cents (1.0 to 4.4 percent). Since the demand for o-dichlorobenzene is more price elastic (although still inelastic: $\varepsilon_D = -.51$), the additional cost translates into a decrease in quantity consumed of greater magnitude. The decrease in consumption is estimated to range from 217,000 lbs. to 932,000 lbs., representing decreases of .53 and 2.25 percent of 1978 production, respectively. Given the nature of this worst case model, the decrease in production is predicated upon the decisions of some firms to move these resources into more productive uses. However, the analysis is incapable of predicting which companies or plants, if any, would be affected.

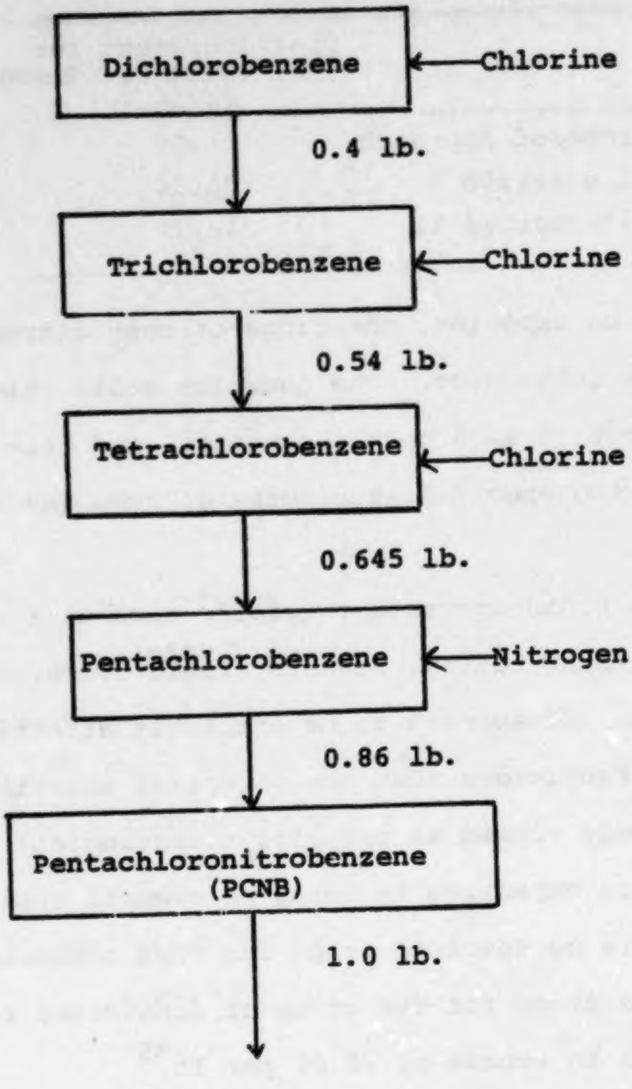
The 1978 production and price for p-dichlorobenzene are approximately the same as for o-dichlorobenzene, and hence, the increases in price are similar, ranging from .27 to 1.2 cents (1.0 to 4.4 percent). However, demand for p-dichlorobenzene is more inelastic (-.16), causing the decrease in consumption to be less. This decrease ranges from 68,000 to 293,000 lbs. (.17 to .71 percent) of 1978 production. Again, for the analysis we cannot determine which producers will be most affected. However, as mentioned in Section IV.B.4.b, the possibility exists that scale economies may place a smaller firm in a less competitive position.

As previously pointed out, while it is statistically possible to derive meaningful demand functions for the lower chlorobenzenes, it is not possible to follow the same procedure for the "higher" compounds in the category. This is a difficult problem to cope with, since on the basis of per-unit costs and production volumes, the higher chlorobenzenes would appear to be more heavily impacted by the proposed test rule. Futher, one of the most important characteristics of the chlorobenzenes system is that the majority of the compounds are manufactured sequentially; e.g., the tri- group is made from the di- group, tetras from the tri- group, and penta- from tetra-. While only a small volume of ortho- and para-dichlorobenzene production goes to produce trichlorobenzenes, one-third to a half of all trichlorobenzenes serve as inputs to tetrachlorobenzene, and all tetra- production goes to pentachlorobenzene.

In addition, all pentachlorobenzene is used to produce a single product; pentachloronitrobenzene (PCNB), a widely used agricultural fungicide. The Olin Corporation is the sole United States producer of pentachlorobenzene and of PCNB.[20] PCNB obviously will have to absorb not only the testing costs associated with its primary product, pentachlorobenzene, but also the testing costs imposed on its "upstream" raw materials, the chlorobenzenes in sequence. This cumulative loading of test costs into a single downstream product is termed "cascading."

Figure IV-6 shows the material flow of chlorobenzenes necessary to produce a pound of PCNB. Weighting the per-pound testint cost increments by material requirements gives the cumulative

FIGURE IV-6 : CHLOROBENZENE MATERIAL FLOW
FOR PCNB PRODUCTION


Dichlorobenzene
Chlorine
0.4 lb.
Trichlorobenzene
Chlorine
0.54 lb.
Tetrachlorobenzene
Chlorine
0.645 lb.
Pentachlorobenzene
Nitrogen
0.86 lb.
Pentachloronitrobenzene (PCNB)
1.0 lb.

cost effect imposed on PCNB. These are shown by regulatory option in Table IV-16.

TABLE IV-16 :

	Cost Increment for PCNB (Worst Case Basis) (¢/lb.)
Proposed Approach	.7¢
Alternative I	28.3¢
Alternative II	13.7¢

As would be expected, the range of cost increments accruing to PCNB is quite wide. The question still remains, however, as to the impact of such cost increments, and this reduces to a question of the specific attributes of PCNB and of the market for it.

PCNB is a broad-spectrum fungicide used on a wide variety of corps, including cotton, peanuts, field crops, and fruits and vegetables. It appears to be extremely effective and easy to use. Fungicides that are potential substitutes for PCNB are not only viewed as inferior technological replacements, but also as more expensive in terms of overall application cost.[23,24] There is no specific price for PCNB publicly available, but the average price for the group of fungicides to which it belongs is well in excess of $2.00 per lb.[35]

Thus, at least preliminarily, it would appear that demand for PCNB is relatively inelastic. If the price of PCNB is taken to be around $2.00 per lb., a 28.3¢ increase (Alternative

I) would amount to 14.2 percent, and would cover the worst possible increment due to testing cost regulations.

An increase of this magnitude must be considered to be significant, but the actual magnitude of impact would be wholly dependent upon demand elasticity. If demand were totally inelastic, industry impact would be zero.

One important unknown involves the role of PCNB imports. Imports of PCNB would not be subject to test cost reimbursement since PCNB is not a TSCA chemical. Thus, it is conceivable that imports could undercut domestic PCNB price and cause a significant shift of resources. The most recent import figures are for 1976 when 33,000 lbs. of PCNB were reportedly received.[14] Roughly, this amounted to one percent of total domestic consumption in that year. This figure, however, sheds little light on whether or not imports are currently a potentially significant market factor.

IV.B.6.b. Summary and Interpretation

The next step in assessing the economic impact of testing requirements would be to evaluate the effect on employment in the industry. This is, typically, derived from employment per unit (e.g., million lbs.) of output for the industry. From the estimate of the decrease in production, an estimate for the decline in industry employment is obtained. Alternatively, from financial information about the production process for each firm, a cost of capital analysis may predict the closing of particular plants, if the existing resources have no alternative uses.

For the present analysis, neither of these methods appears appropriate. First, the decreases in production for the high volume, lower chlorobenzenes represent a small percentage of total production and, in most cases, is a small fraction of the capacity of each company. In addition, as noted in Section IV.B.4.d., the producing companies manufacture a wide range of products at the particular plants and it is believed that in many cases, the resources involved in chlorobenzenes production potentially could be transferred to other activities with a minimum of disruption.

In summary, the maximum decrease in consumption of the three lower chlorobenzenes is estimated to be of 1.30 million lbs., representing a decrease of less than one percent in total production. It appears that the industry would be able to absorb this with minor disruptions.

While the effect of the proposed test rule on the higher chlorobenzenes is not as clear-cut, it is possible to make a tentative presumption that the impact would be minor. The greatest impact due to cost "cascading" would clearly fall on the fungicide, PCNB; but its apparent demand inelasticity, its relatively high price, and the inconclusiveness of evidence on import competition leads to the conclusion that even with the most inflated possible projection of test costs, PCNB will still remain a viable commercial product.

IV.B.7. Limits of Analysis

The above analysis has been conducted using limited information and information of varying reliability. It is essential to consider the analysis in terms of its overall reliability and to judge whether or not the conclusions reached are sound and useable in a regulatory sense.

The strongest results of the analysis rest on two basic sources: (1) estimates of testing costs, and (2) estimates of demand elasticity. Estimates of testing costs have been made on the basis of current market intelligence; however, because these estimates are believed to be highly variable from lab to lab and from test to test, and because specific test protocols are not available, these data are given as ranges rather than point estimates.

In addition to the testing costs estimated here, there are the costs of additional tests that would be required were positive results to occur on the set of minimum test requirements. Further, there are administrative and regulatory costs associated with testing requirements that are not yet well understood and not included. Also, as discussed above, due to the timing of the entire sequence of tests, costs external to those estimated here may be imposed. To compensate for these deficiencies, the "worst case" analysis includes a scenario doubling the high estimate of laboratory testing costs. It is believed that this case should more than compensate for unknown quantities.

Testing costs are formulated here under the assumption that each compound is tested once, in its pure form.

In terms of demand estimation, the methodology employed is very commonly accepted as valid and incorporates its own measures of validity, as explained in the Appendix. The data are more questionable.

Price, for instance, as officially quoted may not be representative of the year's transactions. It may vary widely and quoted figures often do not reflect actual values of the chemicals traded (due, for example, to discounts). However, considerable volumes of chemicals are traded on the open market, and thus, in many respects, these price data are more representative statistically than many other price figures commonly employed in similar studies.

In terms of sensitivity, it is important to note that even if the testing costs are multiplied by, say, a factor of two, as was done to derive the maximum costs, the results are little affected. The results are also very robust with respect to the estimated demand elasticities. For example, if the elasticities are doubled, in order to greatly increase the potential for impact, there is little relative effect on prices and quantities. Thus, while demand estimates might be wide of the mark, there is little reason to believe that this would alter the conclusions to a significant extent.

The assumptions behind annualization of the test costs are also open to criticism. However, a sensitivity analysis of the annualized costs demonstrates that using a shorter capitalization period (10 instead of 20 years) and/or a lower cost of capital (10 percent) has the effect of lowering annualized costs, except when a 20 percent cost of capital is used in conjunction with a 10-year period. In this case, the annualized costs increase about 17 percent. The results of this sensitivity analysis are presented in Table IV-17. The potential error in costs introduced by these assumptions is well within the doubling of costs to account for external factors built into the maximum cost figures. Thus, the results appear to be very robust with respect to the parameters in this model.

IV.B.7. Conclusions

The foregoing analysis leads to the general conclusion that imposition of testing requirements on chlorobenzene producers will, at worst, be small and, at best, be negligible.

This general conclusion follows from several separate findings:

- Annualized testing costs will not be unduly burdensome, particularly if the proposed approach is adopted.
- The elasticity of demand for high volume chlorobenzene compounds is inelastic with respect to price;
- The small, financially marginal producers have already abondoned the chlorobenzene market;
- The growth of export markets has the potential to mitigate the otherwise static outlook for chlorobenzene demand;

TABLE IV-17: SENSITIVITY ANALYSIS OF ANNUALIZED COSTS FOR TETRACHLOROBENZENES

Low Cost Estimate ($440) (From TABLE IV-13)	period (yrs)	Cost of Capital 10%	Cost of Capital 20%
	10	$72	105
	20	52	90

High Cost Estimate ($1,319) (From TABLE IV-13)	period (yrs)	Cost of Capital 10%	Cost of Capital 20%
	10	$215	315
	20	154	271

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[1] All values are in '000 dollars.

- The price and quantity impacts presented in Table IV-16 have been calculated on a "worst case" basis and appear relatively insensitive to data deficiencies and to methodological manipulations;

- Impacts on the higher chlorobenzenes, while not insignificant on a "worst case" basis, will probably be manageable given the nature of demand for these substances;

There are two principal caveats associated with this overall conclusion, however;

- Estimates of demand shifts for o- and p-dichlorobenzenes appear to be of a magnitude that could produce significant impacts on small or marginal firms. This potential would be exacerbated were costs assessed on a per establishment basis, rather than on a production basis;

- If the price elasticity of demand for PCNB imports is high, the conclusions relative to impact on the higher chlorobenzenes could be overly optimistic.

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APPENDIX: ECONOMETRICS AND REGRESSION ANALYSIS

Regression analysis is the statistical tool used by econometricians to estimate relations among variables. Sometimes referred to as "curve-fitting," regression analysis involves representing an economic relationship in the form of a mathematical model or equation. The commonly used form is a linear model:

(1) $y = \alpha + \beta X + u$

where

y = Dependent variable;

α = Constant term or slope intercept;

β = Vectors of slope coefficients;

X = Vector of independent variable(s);

u = Stochastic disturbance term.

The distrubance term, u, reflects the randomness of economic variables and is assumed to be normally and independently distributed with mean zero and constant variance:

(2) $u \sim NI(0, 0^2 I)$

Using these assumptions we can estimate the coefficients of the model from data on the dependent and independent variables and test hypotheses about the relationship.

In order to estimate the parameter coefficients, we wish to derive the curve (for each independent variable, holding all others constant) which best fits the data.

That is, we wish to minimize the combined difference between the curve and each data point. The common method is that of "least squares," where the sum of squared differences is minimized. Of course, squaring the differences eliminates any negative differences and, thus, summing the squared idfferences yields a positive value. The curve which results in the smallest "sum of squares" is the curve which best fits the data.

Any relationship which can be transformed into a linear equation (e.g., by taking logs, squaring, etc.) can be estimated in this manner. One of the most popular relations estimated is the hyperbolic function:

$$(3) \quad y = \alpha X^{\beta} e^{u}$$

This is estimated after taking (natural) logs of both sides of the equation, yielding:

$$(4) \quad \ell n\ y = a + \beta(\ell n\ X) + u$$

The predominant feature of this relationship is that it implies a constant elasticity of y with respect to X (see, Section II.C.2.).

From the estimates of the parameter coeficients and residual statistics, hypotheses concerning the model and its estimation can be tested. The tests fall into two general categories: (a) tests concerning the parameters of the model, and (b) tests concerning the statistical assumptions made.

In this study, we generally report the results of these tests; two of type (a) and the remainder of type (b). The first of these tests is for statistical significance of the estimated equation. This is equivalent to testing whether the true values of all coefficients estimated are all simultaneously equal to zero. This test utilizes the "F-statistic" derived from residual statistics of the estimated equation. The calculated F-statistic is compared to the F-statistic at a given level of significance (e.g., 95 percent) for the appropriate degrees of freedom to accept or reject the hypothesis that the model is insignificant.

To test whether each X has a linear influence on y (or equivalently, whether each β, separately, is equal to zero) we utilize the "t-statistic." This statistic is derived by dividing the coefficient estimate by its estimated standard error. The t-statistics generally are reported in parentheses under the coefficient estimates. When compared with the "critical value" for t, based on the level of significance and degrees of freedom, it is used to test whether the true value of the coefficient is zero.

The final hypothesis test we investigate is the Durbin-Watson test for serial correlation (positive or negative) among the residuals. This tests whether the assumption of independently distributed disturbances is violated. If so, an alternate means of estimation (other than ordinary least squares) which accounts for this is required. Since the method of testing is not as straightforward as for the other tests, we do not attempt to describe it here.*

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*For a discussion of this, as well as all other methods mentioned in this section, see any good econometrics text. Three examples are: Johnston, J., Econometric Methods, 2nd Edition, McGraw Hill, New York, 1972; Intriligator, Michael D., Econometric Models, Techniques, and Applications, Prentice-Hall, New Jersey, 1978; and Pindyck, Robert S. and Daniel L. Rubinfeld, Econometric Models and Economic Forecasts, McGraw-Hill, New York, 1976.